ILLUMINATING ENGINEERING

FEBRUARY, 1949

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Designing Portable Lamps for Lighting Effectiveness

Life and Lumen Maintenance of Fluorescent Lamps

Munsell Scale Values for Judging Reflectance

Modern Street Lighting and Master Planning

Louverall Lighting Technique

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

Now . . . A Classroom Lighting Installation Meeting or Bettering All Recommendations of *American Standard Practice*

An Engineering Report on Over-ALL Lighting by an Independent Consulting Illuminating Engineer.

This is undoubtedly one of the first classrooms to be measured against the recommendations of American Standard Practice for School Lighting, sponsored by I.E.S. and A.I.A., and approved September 20, 1948. This child-conditioned classroom in John Simpson Junior High School, Mansfield, Ohio, meets or betters all artificial lighting requirements of American Standard Practice, as well as (with the exception of the floor) those of the National Council on Schoolhouse Construction.

Description of Classroom: Room 101, John Simpson Junior High School, Mansfield, Ohio. 30 feet long, 22 feet wide, 12 feet high. Ceiling white. Walls yellow and turquoise. Natural finish seating. Light green chalkboards. Ivory tackboards. Double row of diffusion screens mounted at windows.

Lighting Installation: Four continuous rows of two-lamp, 40W Wakefield Star units with luminous indirect plastic reflectors using 3500° white fluorescent lamps.

Weather Conditions: The survey was made on November 26, 1948, seven months after installation. The day was dark and cloudy with sky brightness so low the brightness of the diffuser at the window was approximately the same as that of the wall adjacent to it (66 footlamberts).

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Comparison of Brightness Ratios

	Room 101 John Simpson Junior High School	American Standard Practice for School Lighting	National Council on Schoolhouse Construction
Brightness of paper to brightness of desk top	1 to 1/1.6	1 to 1/3	1 to 1/3
Brightness of paper to brightness of floor	1 to 1/9	1 to 1/10	1 to 1/5
Brightness of paper to brightness of ceiling	1 to 2.78 (max.)	1 to 10	1 to 10
Brightness of luminaires to surfaces adjacent to them in the visual fields	3.4 to 1 (max.)	20 to 1	no recommendation
Brightness difference in the surrounding field between the brightest and darkest surfaces	18.5 to 1	no recommendation	50 to 1
Brightness difference in the peripheral field between the brightest and darkest surfaces	24 to 1	no recommendation	250 to 1
Lighting level	38 ft. c. lowest, 69 average	30 ft. c. min.	20 ft. c. min.

Comparison of Reflectances

Ceiling	Above 85%	80 to 85%	85%
Walls	62 to 70%	50 to 70%	50% min.
Trim	48%	30 to 40%	40 to 60%
Tackboards	67%	50 to 60%	no recom.
Chalkboards	24%	15 to 20%	30% max.
Desk Tops	30 to 55%	35 to 50%	30 to 40%
Floor	22%	15 to 30%	30 to 40%

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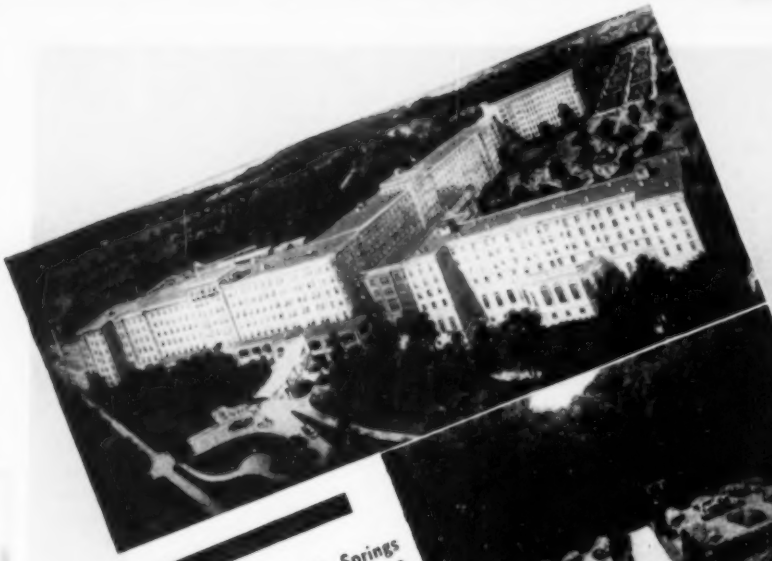

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Designing Portable Lamps for Lighting Effectiveness

By EUGENE W. COMMERY

The analysis, discussion, and measurements set forth aim to clarify the functional objectives that modern floor and table lamps may contribute to the lighting of the home. Standard procedures for testing lamps for various lighting services are included. Quantitative data illustrate the effectiveness of light distribution from various sizes of shades and light sources in obtaining specific levels of illumination. Light source size, brightness, and position are related to both the qualitative and quantitative phases of the problem. Specular effects from a number of widely read periodicals are reported upon. The paper is offered to aid those who design, manufacture, buy and sell portable lamps for use primarily in the home.

THE STYLING TALENTS of hundreds of people have long been applied to the creation of floor, table, and wall-hung lamps. Twice each year some hundreds of lamp manufacturers bring individually designed units, totaling thousands, to their wholesale markets. The search for something different, exotic, and even the bizarre goes on and on. The demand for style innovations and borrowings from the dim past continue. Design is so unhampered that one may even buy lamps using coffee grinders or shotguns for bases.

The Present and the Past

Forty years ago carved mahogany base-and-column floor lamps were as big as the old fashioned rubber trees. If it wasn't a big lamp with a large fringe-trim shade of dark luxurious material, it wasn't worth while. Lamps traveled about every imaginable style channel. Later they became more reasonable in size, diminishing in size until they were almost useless becaues they were offered in such small sizes. Now we are returning to huge and heroic proportioned table lamps. Floor lamps in general have been decreasing in size very slowly for quite some years and now they no longer go through marked swings of styling and sizes. The very nature of their basic elements of base and shaft of course does not permit of the vagaries open to table lamp bases.

Lamp and shade dimensions for the principal floor lamp types have narrowed down to a workable range. On the other hand, there appears to be no basic set of dimensions for table lamps. The one restriction on size in table lamp manufacture is that of cost. However, the lowest cost table lamps today are striving to become larger since a realization of the futility or inadequacy of smaller table lamps seems to have been gained by great numbers of the people in recent years.

While the portable lamp has become a most important element in the lighting of the home today, it has not received the technical attention it deserves to fit it for the role that it has assumed. The swing to greater numbers of portable lamps has been so slow and the emphasis placed upon their decorative attributes has been so great, the industry has difficulty in keeping the real "service-to-be-performed" clearly in mind. Actually, in the whole field of lighting equipments, few can compare in the appeals that may be built or designed into portables. That their lighting performance possibilities are little understood, or even regarded, is not surprising even though regrettable since they can impart so much eye appeal even though deficient.

Portable Lamp Qualities and Values

A proper study of the questions surrounding those points of design bearing on lighting effectiveness and charm should begin with a brief summary of those qualities and values portables already possess. Unlighted, as well as lighted, they have become recognized as important accessories in good interior design. They can supply sophistication, or just be amusing. Through proper selection they can be depended upon to heighten the dignity of a room. Their lighting distribution, and it can be varied substantially, can make a room gloomy or cheerful. The average distribution of light and the form of normal

A paper presented at the National Technical Conference of the Illuminating Engineering Society, Boston, Mass., September 20-24, 1948.

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lamps can always be counted upon to create the atmosphere of "home." Any interior that is basically residential may be softened through their use. The very luminosity of the lamp in itself sets it apart from all other objects in a room and gives it a power to bestow qualities upon its surroundings that no other decorating medium possesses.

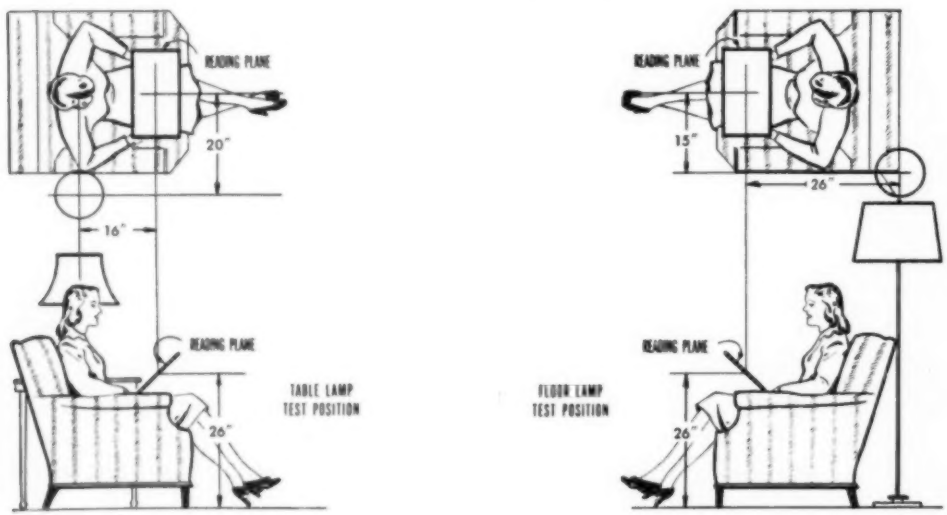
Regardless of the absence of designed lighting performance qualities, they are potent elements in almost every interior in which they are used. Through basic variations of their color and brightness and their light distribution, they do raise or lower the key of a room, from dullness to airiness or the reverse.

The reported analysis, discussion and measurements which follow are offered to aid those who design, manufacture, buy and sell lamps so that those measurable performance qualities and quantities may come into more general use. There is little justification for just a "good looking" lamp when good lighting performance can also be had in this fast-developing age of modern lighting. Discussions on points of styling by itself are not included, although we recognize that currently there are certain accepted dimensions and proportion values that may not be disregarded. This paper is not intended to restrict or unduly modify style factors. Instead, its aim is to set forth the objective values which the designer must work toward. At the same time it contains the results of an extended set of measurements. These are intended to guide the designer in attaining realistic lighting performance results.

Fundamentally, the portable lamp is an element in the evolution of lighting which sought to bring light to bear on some particular area near at hand and in which one wished to see with greater ease. Originally, the light-giving power of sources was so low that there was little chance of doing much, if any, close eye work from sources hung overhead and at any distance from the individual. It didn't take much imagination even in primitive times to grasp the idea that bringing the light to within a foot of those things you had to see made even a feeble flame fairly effective. Obviously, the surroundings must have been very low in brightness, since generally distributed light was so limited, and this brought on visual discomfort — a bare flame within a foot of the eye against dim surroundings. This naturally called for a shade to shield the eyes. After that many mirrored and lens arrangements were tried to assist the low-powered light source, and finally someone merely encircled the source with a reflecting shade, usually closed at the top except for the hole required by a chimney for kerosene and gas.

Aside from its charm and decorating qualities, the portable lamp has won and held favor because it brings light close to things you want to see. This means higher levels of lighting at certain selected areas than any system of lighting spread throughout a room for a given total amount of

Figure 1. Illumination performance is measured on the reading test plane. Table lamp bases placed 25 inches above the floor are to one side, while floor lamps are to the side and rear.



light. Furthermore, they shield the sources of light more effectively than most simple overhead lighting systems. There are few finishing or interior structural problems involved when lighting a room with them, and since they can be moved, they are a boon to renters in particular. Their potential usefulness is easily grasped. If we can rationalize their functional qualities, they can and will take on real stature in the lighting world.

Illumination Level Objectives

We may properly begin our analysis of performance with the question of how much light a useful portable lamp should supply at the point of service. The Society's "Recommended Practice of Home Lighting"[1] includes a series of illumination values without reference to the type of lighting device that is to provide the value. Surface or suspended fixtures or built-in lighting elements may be employed as well as portable lamps. Since this discussion is devoted solely to the latter, we shall examine those lighting situations that appear to be intimately associated with portables as set forth in Table I.

TABLE I—Levels of Illumination for the Home

Visual Work	Current Recommended Practice (Footcandles)
Prolonged reading (smaller type)	40
Casual reading (larger type)	20
Sewing on dark goods, fine needlework	100 or more
Prolonged average sewing	40
Periodic average sewing	20
Writing	20
Children's study table	40
Card table games	10
Dresser and dressing table mirror*	20

*On each side of face.

These illumination levels aim to fit the light to the typical home tasks for persons with normal vision, with due consideration to such matters as cost and practical attainability. The levels do not represent the optimum since under some conditions more light may be necessary, desirable and often attainable. While portable lamps have not been usually considered for their ability to supply significant levels of general lighting in such rooms as the living room, a proper selection and arrangement of them will result in satisfactory general lighting. The current recommended practice includes five footcandles for the general lighting of the living room, library, sunroom and bedroom.

Test Planes and Their Locations

The table states the illumination values, but does not locate the position or the extent of the area that is to be so illuminated. For reading and writing, a minimum area, 14 inches wide and 12 inches deep, has been selected. Its location with respect to the floor, the reader and the portable lamp, when serving chairs and davenports, is illustrated in Fig. 1. It should be noted that floor lamps are located farther back from the reading test plane than table lamps. The test positioning for each type, while arbitrary, is highly realistic. Other positions could be assumed, but it is doubtful whether any important gain would be effected by changing. In fact, much service to the homes of the country could be provided if each could have copies of these figures. This simple information would aid the homemaker all the way from the time she purchased a lamp on through to the day it was discarded years later. The importance of positioning, both in testing and in use, cannot be over-emphasized. Generally speaking, portable lamps serve well if they are used intelligently. The amazing prevalence of improper placing and selection in homes and in hundreds of illustrations in the design, decorating and advertising worlds means that the service function of lamps is but little understood. The first corrective step is a standard for test procedure. Until we accept this proposition, there is no way to aid manufacturers who glibly assure themselves that they have some innovation of design that supplies "light in the right amount and the proper directions." In fact, many forms of confusion can only be eliminated through logical procedures for all performance characteristics. The need for evaluating lamps upon generalities is only forced upon us when we don't have facts. Today we can go from the general to the specific.

The same size of test plane is also prescribed for writing on desks and study tables, 14 x 12 inches. In this case, however, the test plane is to be placed on a typical desk 30 inches high and tilted toward the user 30 degrees from the horizontal desk top.[2] This tilting is introduced in an endeavor to bring the line of vision normal to the writing or reading surface. From the careful observations reported on home study conditions by Miss M. E. Webber,[3] this tilting interferes with illumination levels and uniformity to such an extent that it is for the present a doubtful part of this testing procedure. Fig. 2 presents the plan and elevation of desk top, test plane and the location of lamp base when testing table lamps. This should also become a use chart for the family.

In addition to these applications of portable lamps for reading and writing, there should be prescribed test conditions for evaluating the worth of lamps for reading in bed. The test procedure developed here from suggestions made by Miss Priscilla Presbrey and Miss Myrtle Fahs-

bender resulting from their studies[4] of conditions associated with this problem is illustrated in Fig. 3.

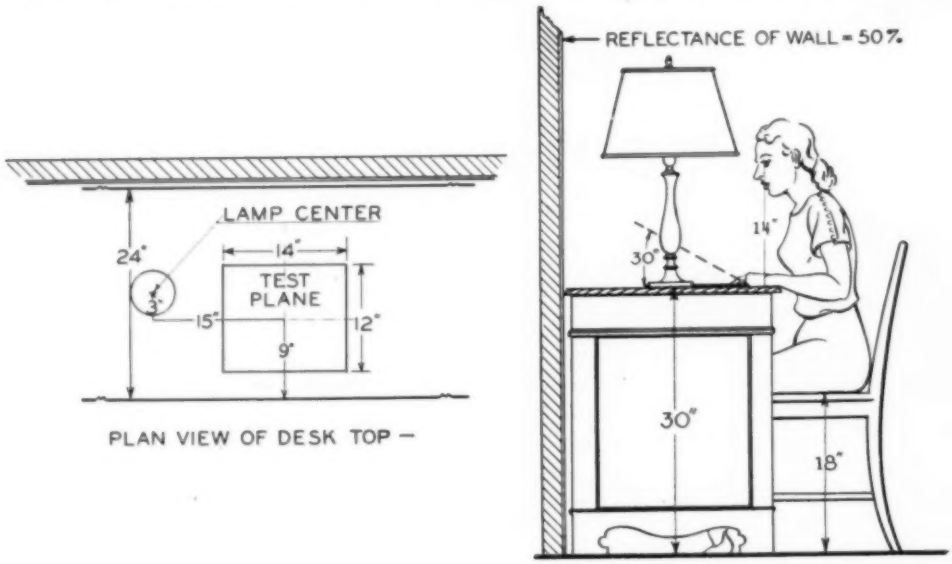
The remaining specific service requiring test procedure is that for the lighting values of dresser and dressing table lamps. The positioning of mirror, lamps and illumination test areas is indicated in Fig. 4. The vertical test plane areas are 6 x 6 inches and 6 inches apart, placed in the positions of the two sides of the face. These planes are turned normal to a vertical plane passed through the center of the shades of the portables. In addition to the 20 footcandles required on these test planes, one-half this value, or 10 footcandles, must be supplied to an added border area two inches wide on all four sides of the plane. This is to insure an illumination pattern with at least a reasonable tapering-off boundary.

The foregoing establishes the first two basic steps in approaching the lighting performance design problem — attainment of specific levels of illumination and their delivery to precisely defined areas of service. The illumination level objectives are embodied in the Society's pertinent publications.[1, 2] The extent and exact positionings of the areas to be served are in the Society's Lighting Performance Recommendations . . . , the present C.L.M. specifications,[5] or are for the first time, in the case of study desks and bed reading, suggested[3, 4] and proposed here.

Opaque and Diffuse Reflectors

The illumination levels delivered by any given portable lamp are dependent in a large measure upon the amount of light given off by the light source used. We can, however, obtain entirely different illumination levels from, for example, a 150-watt lamp, in each of two identical table lamps, through the simple expedient of equipping them with entirely different reflectors. If one uses a good quality polished metal reflector to throw all of the light upward, you might expect to obtain around eight footcandles on the standard test plane, Fig. 1. The other table lamp, equipped with a large low-brightness reflector bowl, supplies nearly 20 footcandles. In the first case none of the light reached the reading test plane direct from the source inside the shade. It had to be reflected back from the upper walls and ceiling. Much of it was scattered throughout the room and only a small part ever reached the reading plane. The part that did reach this plane was, however, highly diffused. Reflections from even the glossiest papers and printing inks would be scarcely noticeable. Visual discomfort sensations produced by bright spots off the reading or writing surface would be nearly eliminated and black ink on white paper would look black. This degree of light diffusion permits reading and writing on the shiniest paper and ink one would ever encounter. In fact, such high diffusion is scarcely ever

Figure 2. Suggested positions of lamp and working test plane for desk or study lamp illumination performance tests.



needed in the home as will be noted later when the surface effects from seventeen pages taken from a number of widely read periodicals are discussed — see Table II. The attainment of 20 reading-plane footcandles by this method (indirect only) would require approximately 375 watts. This illumination value can be obtained from the same well-proportioned table lamp for as little as 75 watts using a bare inside frosted lamp or with about 160 watts using a large low-brightness diffusing bowl with an inside frosted lamp. In each example the measured illumination is the same, but the possibilities of enjoying an evening with a newspaper, book or magazine are entirely different. Obviously, the bare inside frosted lamp is by far the least desirable. The indirect reflector combination would be good except for the rather questionable economy of the arrangement and the actual difficulty of living in the room when all the members of the family turn on their respective lamps. Upper wall and ceiling brightnesses near and above each lamp would be troublesome and often esthetically undesirable. As is the case with many design problems, there is a point in between the two extremes of indirect and direct lighting from small high-brightness light sources that will best serve for most uses. The means to this end is found by increasing the size of the source inside the shade, as "viewed from the test plane," to the greatest possible degree. Any diffusing material below the light source could be used except that we want it to transmit light as much as possible without revealing the source through it. Open bowls, enclosing globes and reflectors with sections drawn in at the center are used to enlarge the source as viewed from the test plane and to increase or decrease the proportions of the upward and downward light, Fig. 5.

Visualizing Design From the Test Plane

In many of the following paragraphs (as above) the expression "viewed from the test plane" will be used. It affords a short cut in both thinking and in expression when dealing with the subject. In fact, the problem of getting illumination to the various test planes for reading, writing at desks, or for that matter in bed, can be visualized much more easily if we place one eye back of the test plane and then look at the lamp to be analyzed or developed. This procedure can be undertaken more simply and effectively with a piece of cardboard having small holes spaced over it. The card, 14 x 12 inches (test plane size), is held in the regular test position. The portable to be examined is then viewed through each hole separately. The luminous parts of the lamp are easily noted at each position. Only the elements of the luminous parts that are visible at each hole, however, supply direct illumination to that part of the test plane immediately around the hole.

Many points of design effectiveness can be ob-

(Continued on page 112)

TABLE II

Observations of Visual Discomfort and Visibility Created When Lighting and Viewing Magazines at Various Angles Under Identical Conditions of Lighting

Normal Illumination 25 footcandles, diffuse light source 2250 footlamberts

Periodical Viewed	Angle of Incident Light — Discomfort Sensation 30°	40°	50°	Visibility 30°	40°	50°
A-w	Quite low	Quite low	Quite low	Small reduction	Small reduction	Marked reduction
B_1-w	Noticeable	Noticeable	Marked	Substantial reduction	Substantial reduction	Very marked reduction
B_2-w	Marked	Marked	Very marked	Marked reduction	Further reduction	Nearly invisible
C_1-m	Moderate	Moderate	Marked	Small reduction	Moderate reduction	Well above invisibility
C_2-m	Noticeable	Noticeable	Marked	Moderate reduction	Moderate reduction	Slightly above invisibility
D_1-w	Noticeable	Great	High	Marked reduction	Difficult to read	Essentially invisible
D_2-w	Marked	Great	High	Marked reduction	Difficult to read	Essentially invisible
E_1-m	Noticeable	Noticeable	Very marked	Small reduction	Small reduction	Marked reduction
E_2-m	Marked	Marked	Very marked	Small reduction	Substantial reduction	Slightly above invisibility
F-m	Noticeable	Marked	Very marked	Small reduction	Further reduction	Essentially invisible
G-m	Marked	Very marked	High	Marked reduction	Nearly invisible	Invisible
H_1-m	Noticeable	More noticeable	Moderate	Small reduction	Substantial reduction	Invisible
H_2-m	Marked	Very marked	Very marked	Marked reduction	Slightly above invisibility	Invisible
I-m	Noticeable	Noticeable	Marked	Moderate reduction	Further reduction	Essentially invisible
J_1-d	Very low	Low	Noticeable	Slight reduction	Further reduction	Well above invisibility
J_2-w	Noticeable	Noticeable	Marked	Small reduction	Further reduction	Well above invisibility
K	Moderate	Marked	Very marked	Marked reduction	Nearly invisible	Essentially invisible

Periodicals are monthly or weekly as indicated by the letters m and w. J_1-d is a metropolitan daily. J_2-w is the weekly pictorial magazine supplied with J_1-d. B_1-w and B_2-w are taken from two parts of a weekly pictorial. B_1-w, B_2-w and J_2-w are rotogravure, and all others are printed letter press. Except for K, one or more of these magazines are read in millions of homes. Circulation figures indicate over 50,000,000 copies a month for this group. K is published by a national engineering society. The surface characteristics of D_1-w, D_2-w, G-m and K are the most undesirable on both points of appraisal.

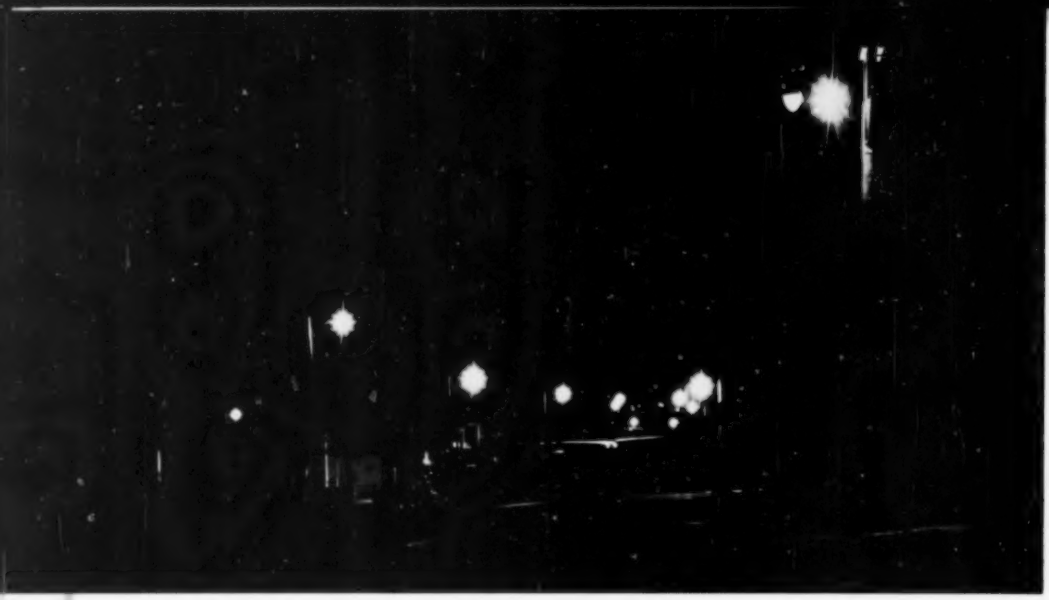


Figure 1. South San Francisco street before relighting. 2500-lumen and 4000-lumen lamps in old refractor type units (refractors removed) have been employed.

Modern Street Lighting and Master Planning

By G. A. TROSPER

MANY years of additions to the street lighting systems in Northern California have resulted in a great variety of equipment in service. Various manufacturers have sold the newer developments in street lights and standards year after year. City Improvement Leagues or business groups have had considerable weight in causing city councils to select "special" designs for various streets to be lighted. All of this together has resulted in a great conglomeration of equipment. Since most lighting service contracts require that the obsolete equipment be maintained, it lives on into modern times, often becoming an eye sore and a wasteful tax-eater. As a matter of fact, many pieces of street lighting equipment in use at the time of the San Francisco earthquake are *still* in use in this area!

Near the close of the last war, when we felt we could look about us and review our own methods, we could see definite need for improvement in our street lighting practices. The cost of maintenance, including the warehousing and distribution of many separate items, was mounting rapidly. A study of the glass requirements showed that we were using 77 different kinds and sizes. It was becoming increasingly difficult to service many of the older units as parts could no longer be obtained and had to be made up locally. Good and efficient street lighting is practicable with the use of perhaps 15 or 20 parts which, when assembled, make only 8 or 10 different kinds of street lights (Fig. 3). Compare this with older practices which use something like 750 parts! Put together they make up about 150 different street lights.

The Problem of Replacement

It is obvious, however, that as newer methods and units are developed, some way must be found to change over from old to new, and with the least posible expense. Most large organizations, public and private, observe a certain write-off of

MR. TROSPER is with the Pacific Gas and Electric Co., San Francisco, Calif.

Figure 2. Same street as shown in Figure 1 after relighting with twice as many units as old job. 4000-lumen Type V units with new type bracket (no brace) have been employed. Lighting level is approximately 0.4 footcandles.

Very few parts are required for street lighting equipment — yet it is necessary to stock great numbers. A member well acquainted with the planning of street lighting installations has outlined a Master Plan for the field application of the Society's Recommended Practice for Street and Highway Lighting.

values. In addition, funds provided in service charges are set aside for upkeep and replacement. But very few programs have been set up for the automatic replacement of equipment after it has lived its useful life.

It is suggested that rate structures be revised to cover costs of modern methods and equipment. At the same time slightly more weight could be given to replacement funds so that at the end of a given period of time, equipment could automatically be replaced. This method, as it appears to the author, would be the easiest and least painful of any. Thus could the never ending march of science do an effective job for the general public.

Modern engineering practices are now setting the pace and modern minded utilities are endeavoring to keep up with them. The Society's Recommended Practices of Street and Highway Lighting has been tentatively adopted in Northern California. The I.E.S. studies and reports which resulted in the new Standards have come to us just in time and the procedure of putting them into use does not appear too difficult.

Interchangeable Parts

In a far-flung electric utility, interchangeable parts and standard methods and practices are all-important. For instance, it is of considerable value in the saving of time and expense to the utility to have only one or two types of street light hoods in the field, and but three or four types of glass-reflector assemblies on the truck, with the serviceman knowing that they will fit. Standardization of equipment was one of the first items we were interested in establishing.

After selecting a good line of parts, we looked about to obtain interchangeable parts from manufacturers. We have been fortunate in finding several manufacturers who will supply these parts. Now we can be assured of obtaining the right type and kind of the street lights we need to give the public good roadway illumination.

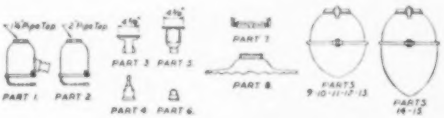


Figure 3. Good and efficient street lighting is practicable with the use of only 15 or 20 parts, which when assembled, make only 8 or 10 different kinds of street lights.

Figure 4. Installation at Eureka, California, using 600-cp units on trolley poles.

Master Planning

At the close of the war, city officials discovered that they needed additional street lights in all sections of their cities, and that most of their existing equipment was obsolete and inadequate. This offered an opportunity for planning afresh. When city engineers and managers were approached, they welcomed the idea of over-all planning, but they had no one to do the specific work. Upon the utilities' offer to work up the plans, the cities accepted it as a way to help the modernizing of their streets. The actual changes and installations can be made gradually, with the only expense to the city being the extra lights or the increased sizes that would be required. It was long-range planning, and each new unit that went in was in accord with the plans. It was "Master Planning."

The methods and approach to the task of laying out a Master Plan are of interest. A quick review of the patterns and shape of most American cities indicates certain physical conditions common to all. For instance, without exception, there are one or more Primary Business Areas in each town or city, and one or more Primary Arterials leading into each of them. Modern traffic has dictated more or less, a fixed method of illumination for such streets, and particular methods of lighting for such traffic have been developed. It was also observed that each city has Secondary Arterials as well as Secondary Business Areas. All cities have specific Residential Areas and some have Restricted Residential Areas. Most have more or less definite Industrial Areas.

It is fundamental that each area should be treated separately, with each having the kind of lighting it requires and could economically install.

The paramount factor of importance is public safety. That need, alone, justifies the cost of adequate street illumination for pedestrians as well as motorists. Modern cities on cross country highways are also interested in the impression that is left on the tourist's mind as he passes through.

The survey and studies made showed the need for a common approach which, in itself, could become a standard practice. In approaching the task of making a Master Street Lighting Plan, it was found that the following several parts of a city should be taken up and studied in turn:

Primary Business Area
Secondary Business Area
Primary Arterials
Secondary Arterials
Industrial Area
Residential Area
Restricted Residential Area, if any

It was found, also, that each area could be identified on a suitable map by a color applied to the streets. For cities of average size (2,000 to 15,000 population), one large map with a scale of 200 feet to the inch was found about right. The author used the following colors to identify the several streets:

Yellow	—	Primary Business Area
Orange	—	Secondary Business Area
Red Dashes	—	Primary Arterials
Green Dashes	—	Secondary Arterials
Brown (light)	—	Industrial Area
No color	—	Residential Area
Light Blue	—	Restricted Residential

It is a part of the job of the engineer to study not only day and night traffic flows, but the habits of the citizens as they travel about town. City Managers and Engineers often can give valuable information in these respects. By force of habit and perhaps good and bad street illumination, citizens of a community will develop certain travel habits and patterns. They are inclined to take

the right-of-way for granted even if they cannot see what is ahead of them. Butcher boys and milk wagons will go around corners on two wheels and on the wrong side of the street. Occasionally someone gets hurt, but the habit is well established.

Other important items are winter conditions *vs.* summer conditions: (five P.M. in June on a busy corner *vs.* five P.M. in December); shade tree problems, traffic volumes at pressure points and, not the least, the merchants' point of view re window shopping and pedestrian traffic. The safety of pedestrians as they walk home alone is also a must.

After all factors were well cataloged and analyzed, the layout was planned. It was imperative that the engineer visit every street to check the present lighting and to relocate it, if necessary. Field maps were used to list changes, etc.

Future growth of a city is of prime importance to city officials and a discussion with them will supply much information. In addition, careful observation of building trends will be helpful.

It was found necessary to set up a group of symbols to denote the kinds and sizes of street lights. The author developed such a group of symbols using rubber stamps which were shaped like the I.E.S. light distribution patterns, as shown below. The stamps were secured to four-inch sticks for easy handling.

I.E.S.	TYPE I	TWO-WAY DISTRIBUTION
"	TYPE II	NARROW ASYMMETRIC DISTRIBUTION
"	TYPE III	MEDIUM " "
"	TYPE IV	WIDE " "
"	TYPE V	SYMMETRIC DISTRIBUTION

These symbols were of a size that fitted in nicely on a map with a scale of 200 or 300 feet to the inch. The map shown in Fig. 7 demonstrates a section of a city, marked with these symbols and other Master Plan data.

In order that size of units may be readily observed on the map, a color code was devised as follows:

1,000 lumen	Black
2,500 lumen	No color
4,000 lumen	Purple
6,000 lumen	Heliotrope
10,000 lumen	Bright Blue
15,000* lumen and up	Red or Crimson

*(the size of the large units noted alongside)

A large red circle was used to designate those corners of intersections which are known to be "Accident Areas."

Figure 5. The start of a Master Plan program. In this relighting job in Eureka, California, 6000-lumen Type IV units have employed on 100-foot spacing. Four-foot locally made arms are mounted 25 feet over street on old trolley poles, with overhead single wire loop feed. Lighting value with the old (upright) installation was about 0.2 footcandles. Lighting value with the new installation shown is 0.65 footcandles, using the same size lamps.

While the color symbols described appear on the Master Plan map in their actual colors, it has been necessary in the sample map shown in Fig. 7 to show them as different patterns. The box in the left-hand lower corner of the map gives the key to the patterns which designate the colors used on the Master Plan map.

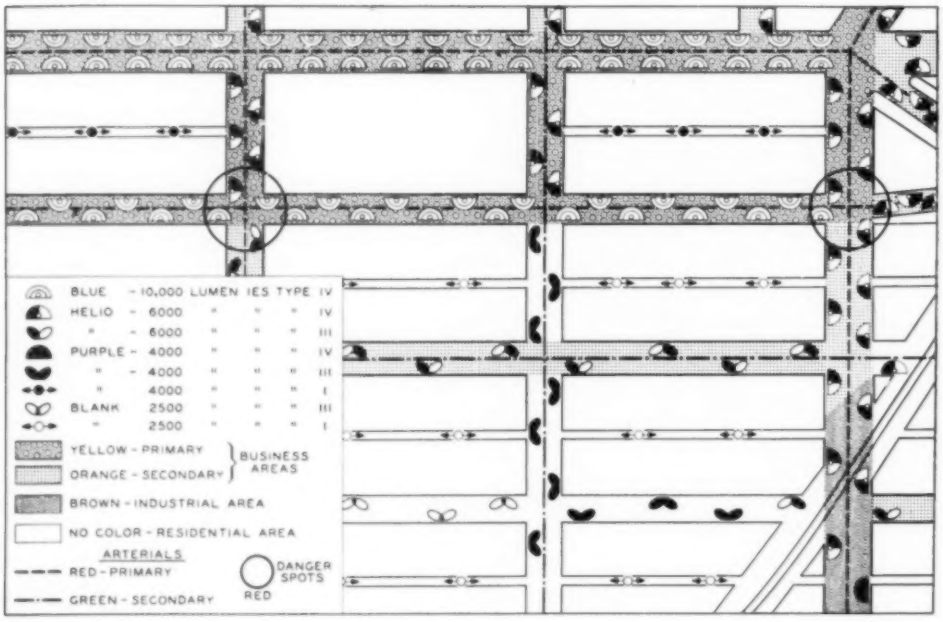
With these color codes and symbols, it was possible to lay out a complete lighting pattern for a city. Where the city was larger than could be handled on one map, several sections were used. In all cases, the streets on the maps were clear of any markings to start with.

When all the information was cataloged and the lights spotted on the field map in the form of types and sizes of lights required at their proper locations, the final spotting of the lights on the master tracing was done by use of the rubber stamps. As many prints of the map were then made as were required. It was found that blueline prints were the most satisfactory final prints to use. Care was used to obtain a good ink for the rubber stamp symbols which would print well on tracing cloth. A good stamp pad was made by using a cross section of fine grain Balsa wood in place of the regular stamp pad. Coloring of the symbols to indicate various lamp sizes was then done by hand, as no other method was found practicable. Coloring of streets to indicate type of area (business, residential, etc.) also was done by hand. A leather bound gold embossed brochure has been worked up giving comprehensive information developed in forming the plan.

Figure 6. Four-foot upsweep street lighting bracket made from 1¼" pipe equipped with pole plate and adjustable end fitting; ½" thrubolt at top of pole plate. This unit will support a 200-pound man on its outer end, though taking up a small space on the pole.

Some thirty cities in the San Francisco area have asked for these plans. Standardization pays! Such a Master Plan will undoubtedly be of assistance to other cities in planning their future growth and activity.

Figure 7. Master Plan map demonstrating a section of a city, marked with I.E.S. Type symbols and other Master Plan Data.


BLUE - 10,000 LUMEN IES TYPE IV
HELIO - 6000 " " " IV
" - 6000 " " " III
PURPLE - 4000 " " " IV
" - 4000 " " " III
" 4000 " " " I
BLANK 2500 " " " III
" 2500 " " " I
YELLOW - PRIMARY
ORANGE - SECONDARY
BUSINESS AREAS
BROWN - INDUSTRIAL AREA
NO COLOR - RESIDENTIAL AREA
ARTERIALS
RED - PRIMARY
GREEN - SECONDARY
DANGER SPOTS
RED

Louverall Lighting Techniques

By BENJAMIN S. BENSON, JR.

Immediately following the introduction of any radically different product or method there is a transition period during which time little information is available. Expectations are based on hopes, and because of the insistent clamoring of the public for immediate information on the new product, investigations proceed at a full gallop. Such is the case with louverall ceilings. Included in this paper are the results of tests on louverall ceilings which, it is sincerely hoped, will contribute to the knowledge of illumination personae and aid them in their employment of this new lighting technique.

THERE ARE FOUR basic considerations in louverall lighting installations bearing directly on the quality of illumination obtained, and user satisfaction. These are as follows:

1. Adequate shielding
2. High system efficiency
3. Pleasing appearance
4. Minimum direct and reflected glare

Shielding

The prime consideration for any louverall system is, of course, proper shielding. Many different shielding angles or combinations thereof have been advocated and put into practice. Since these systems are relatively new there has been little standardization.

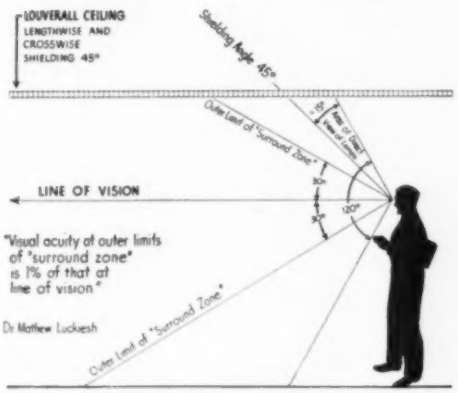
Let us for a moment investigate the information available on the subject of shielding. Fig. 1 illustrates a vertical cross-section of the visual field for a horizontal line-of-sight as set forth by Luckiesh.[1] The entire visual field extends approximately 60 degrees above and below the line of vision. At 30 degrees above the axis of vision, visual acuity is reduced to only one-hundredth that at the line of vision. Similar to the reduction in visual acuity, the effect of a glare source decreases as its angle from the line of vision increases. A compromise at a shielding angle of 45 degrees (halfway between the 30° limit of the surround zone and the 60° limit of the upper visual field) would mean that for a horizontal line of vision there would be an unshielded angle of approximately 15 degrees located at the upper limit of the visual field and causing little if any sensation to the eye.

In schools, offices, and the like, the line of vision is generally horizontal or below. A 45° shielding provides good protection for these conditions and satisfactory protection for those occasional glances above the horizontal.

The 45° shielding angle has been generally accepted as good practice as evidenced by the statement in the report of the Office Lighting Committee of the Illuminating Engineering Society that, "To protect the eyes in the potential direct glare zone, luminaires should be shielded to about 45 degrees. . . ."[2]

Experience has proven that louverall ceilings should have identical lengthwise and crosswise shielding. The terms "lengthwise" and "crosswise" refer to the orientation of the louver vanes with respect to the fluorescent lighting equipment above them. In some instances louverall ceilings have provided 45° crosswise and 30° lengthwise shielding — the theory being that the fluorescent lamps when viewed lengthwise, are less bright than when viewed crosswise and consequently less shielding is required. Measurement of bare lamp brightnesses at an angle of 45 degrees above the

Figure 1. Vertical cross-section of the visual field for a horizontal line-of-sight as set forth by Luckiesh.

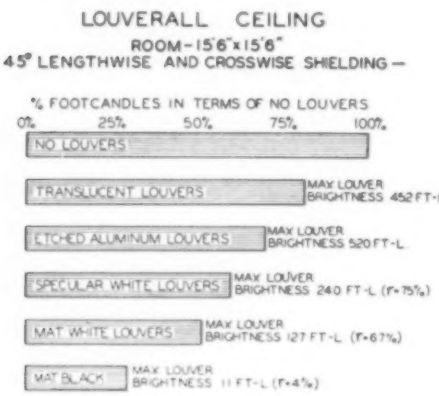

LOUVERALL CEILING
LENGTHWISE AND CROSSWISE SHIELDING 45°
Shielding Angle 45°
Outer Limit of "Surround Zone"
LINE OF VISION
30°
60°
120°
"Visual acuity at outer limits of "surround zone" is 1% of that at line of vision"
Dr Matthew Luckiesh
Outer Limit of "Surround Zone"

A paper presented at the National Technical Conference of the Illuminating Engineering Society, Boston, Mass., September 20-24, 1948. BENJAMIN S. BENSON, JR., is with the Benjamin Electric Mfg. Company, Des Plaines, Ill.

horizontal indicates that the lengthwise brightness was no more than 12 per cent less than the crosswise brightness. At 30 degrees above the horizontal the lengthwise brightness was 24 per cent less than the crosswise brightness. While it is true that lamp brightness is lower in this one direction it does not appear to be sufficiently reduced to permit a lengthwise shielding of only 30 degrees.

Another factor to consider is the flexibility of fluorescent equipment arrangement over the louvers. Providing equal crosswise and lengthwise shielding allows the lamps to be placed in either direction without danger of violating the recommended shielding angle. In some cases the user desires incandescent lighting in conjunction with louverall ceilings. Here, certainly, equal shieldings are required.

Figure 2. Results of tests with various louver materials in experimental room, using 4500° white fluorescent lamps.



In determining the spacing of the vanes making up the louvers, a cell opening of two inches appears most satisfactory from the standpoint of appearance. Cell openings much larger than two inches seem to be "eye-catchers" in that the casual glance, resting momentarily on a section of large-cell louvers, has a tendency to explore into the cells and to see what is above. The two inch cell eliminates this tendency.

Since user preference tends toward smaller cell openings, a high efficiency of the louver material is most important in achieving best performance of the entire louverall system.

Louver Materials

Louver vane materials in general use at the present time include plaster, painted wood, painted

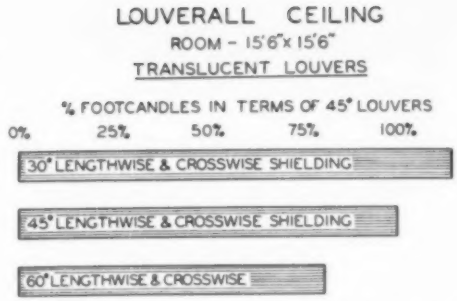


Figure 3. Results of tests in experimental room, using translucent louvers with both crosswise and lengthwise shielding angles of 30, 45 and 60 degrees.

steel, etched or painted aluminum and plastic. The range of reflection factors for paints and aluminum are more or less familiar to everyone so these will not be dwelt upon. The reflection and transmission factor of plastic is more complex and is worthy of a few words of discussion at this time. Plastics can be obtained in a wide range from colorless transparent through a variety of colors and translucencies, to black. From this range it would be possible to select those plastics that would closely approximate the reflection characteristics of certain paint finishes. However, such a choice would be overlooking the great advantage certain plastics have in being able to both transmit and reflect light. With this in mind a study was made leading toward a translucent louverall ceiling.

Starting with a colorless transparent plastic, opacifiers were added to provide transluceney. The addition of opacifiers resulted in a decrease in transmission, an increase in reflectance, and an increase in light absorption. Light transmitted through this plastic assumed a somewhat yellow cast. To eliminate this yellow cast, pigments were added which increased the reflectance somewhat but at the same time decreased the transmission to such an extent that this method of achieving transluceney was ruled out as unsatisfactory from the standpoint of efficiency.

The plastic, vinyl chloride acetate, was finally selected as it was practically colorless and made no apparent change in color of transmitted light. The required transluceney was provided by the exterior finish, a finish more closely approximating a fine grain surface than an etched or sand-blasted finish. It was found that this material had a combined transmission and reflection factor of 94 per cent.

System Utilization Efficiencies

An experimental room was established to test actual louverall installations using various louver materials. The room dimensions were 15′–6″ x 15′–6″ with a 9′–2″ distance from floor to the bottom of the louvers. A total of 15 three-lamp 40-watt RLM fluorescent closed-end reflector units were mounted above with a distance of 18″ from the top of the louvers to the bottom of the reflector. Lamps used were 4500° white. Reflection factor of the ceiling recess was 75 per cent, walls 50 per cent and floor 14 per cent. The louver cells were 2″ x 2″ x 2″ providing 45° lengthwise and crosswise shielding. The following louver materials and finishes were used:

Translucent plastic (vinyl chloride acetate)—combined transmission and reflection factor 94 per cent

Aluminum (3 minute etch)—reflection factor 76 per cent

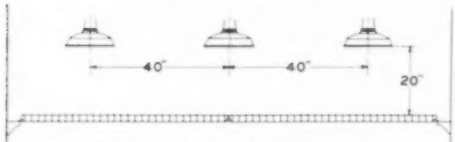
White paint, specular (so-called)—reflection factor 75 per cent

White paint, matte (so-called)—reflection factor 67 per cent

Black paint, matte (so-called)—reflection factor 4 per cent

The results of the above tests are tabulated in Fig. 2 in per cent of footcandles based on the system operated with all louvers removed. Under the given conditions, the louverall system with translucent louvers was found to be 16 per cent more efficient than the aluminum; 35 per cent more efficient than the specular white; 57 per cent more efficient than the matte white and, as could be expected, 171 per cent more efficient than the black. Brightnesses shown in Fig. 2 are maximum at 45 degrees above the horizontal. Brightnesses will vary according to the degree of specularity and the reflection factor of the finishes of the totally opaque louvers. It was found that while the system efficiency of the translucent louvers was 16 per cent greater than the aluminum louvers, the maximum brightness of the translucent louvers at 45 degrees was only 87 per cent of the maximum brightness of the aluminum louvers.

TRANSLUCENT LOUVERALL CEILING WITH INCANDESCENT REFLECTORS



AREA OF ROOM = 10′8″ x 21′4″ = 227 SQ.FT.
DISTANCE FLOOR TO LOUVERS = 9′2″
REFLECTOR EQUIPMENT = 150 WATT INCANDESCENT RLM DOMES.
REFLECTOR SPACING = 40" x 36"
TOTAL REFLECTORS = 21
TOTAL LIGHTING LOAD = 3150 WATTS.
HEIGHT OF WORKING PLANE = 30"

LAMP	PERCENT FT-C	MAXIMUM BRIGHTNESS 45°	APPEARANCE
CLEAR	100	488 FT-L	STRIAE OVER WORK PLANE AND SIDE WALLS.
INSIDE FROST	95	448 FT-L	STRIAE OVER SIDE WALLS, NOT NOTICABLE ON WORK PLANE.
WHITE BOWL	80	371 FT-L	STRIAE PRATICALLY ELIMINATED ON SIDE WALLS, NONE ON WORK PLANE.
BOWL SILVERED	68	339 FT-L	SAME AS WHITE BOWL LAMP.

Figure 4. Arrangement and results of test of louverall translucent plastic ceiling using 150-watt incandescent RLM dome reflectors.

Fig. 3 shows the results of tests made in the above mentioned experimental room using translucent louvers with both crosswise and lengthwise shielding angles of 30 degrees, 45 degrees and 60 degrees. In all cases the cell dimensions remained two inches square with the depth varying to provide the shielding desired. It was found under these conditions that while the 30° louver was 14.5 per cent more efficient than the 45° system, the latter was 19 per cent more efficient than the 60° louver system. It is quite evident that as the degree of shielding increases, the efficiency of the system drops sharply.

Bare fluorescent lamps have been used above louverall ceilings in many instances. An installation of this nature depends upon the ceiling recess to act as the reflector and consequently introduces a large number of variables affecting the efficiency of the louverall system. If the ceiling recess is shallow with respect to its length and width, unbroken by a multiplicity of pipes, etc., often times found on the job, and finished in a white paint of high reflectance (around 80 to 85 per cent), the initial efficiency of the system is quite satisfactory. As the bare lamp installation depends on the ceiling recess for its efficiency, it is necessary that the ceiling recess be well maintained and frequently refinished. When the ceiling recess has greater depth, a considerable amount of light is lost above the louvers and results in a lowered system efficiency.

A series of tests were run using 150-watt incandescent RLM dome reflectors over a louverall ceiling of translucent plastic. The details of arrangement as well as results are given in Fig. 4. The reflection factor of the ceiling recess was 80 per cent; walls 55 per cent; floor 17 per cent. One of the problems in using incandescent lighting equipment above louverall ceilings is that of the shadow patterns on the side walls caused by the various cut-offs of each individual louver vane

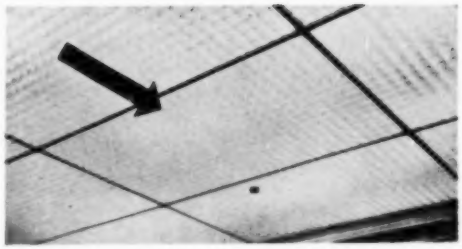
with respect to the concentrated incandescent light sources above. These shadow patterns exist for both translucent and opaque louver materials, however as may be expected, the condition is more pronounced with opaque vanes. The use of clear incandescent lamps with a translucent louverall system is definitely not recommended as the result is such an interlacing of striae, not only on the walls but on the working plane as well, as to prove extremely distracting to anyone attempting to work under such conditions. The substitution of inside frosted lamps smoothed out the striae on the working plane but those on the upper portions of the side walls still were quite noticeable. The substitution of white bowl or inside frosted bowl silvered lamps washed out practically all striae on the side walls. Tests and observations revealed that while louverall systems using white bowl lamps are lower in overall efficiency than those using either the clear or inside frosted lamps, white bowl lamps are recommended from the standpoint of appearance weighed against system efficiency.

Appearance

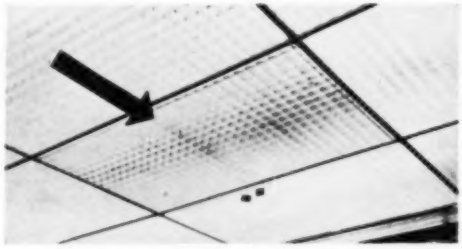
A favorable appearance in louverall ceilings results from two separate lighting patterns on the louver system itself. The first pattern is that caused *in* the individual louver cells as a result of the various cut-offs, transmissions and interreflections in the louver vanes. This pattern provides the inherent pleasing appearance of louverall ceilings in general. The second pattern is that caused by the variation in the integrated brightness of individual cells over any given section of louverall ceiling. While a certain amount of variation is permissible, too great a variation will result in noticeable streaks of light and shadow producing a mottled appearance over the louverall system. Placing the lighting units too close together will tend to eliminate the pleasing cell pattern and produce a flat monotonous appearance. When lighting units are too far apart the mottled appearance will be evidenced. Here a compromise must be effected. With translucent louverall systems a pleasing appearance is obtained when the lighting equipment spacing is approximately twice the distance from the bottom of the equipment to the top of the louvers.

Fig. 5 shows four photographs of a portion of a translucent louverall ceiling with the center panels (indicated by arrows) of different materials or finishes in each photograph. As indicated in the caption, the film exposure was identical for each photograph.

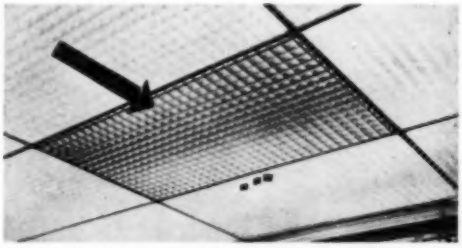
The photograph "A" shows the center panel of



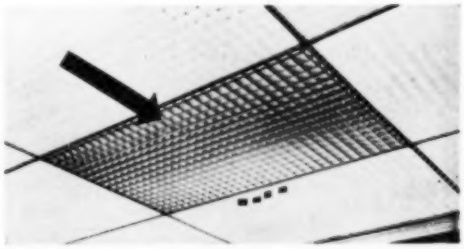
Center panel louvers translucent.



Center panel opaque. Etched aluminum.



Center panel opaque. Specular white paint. RF = 75%.



Center panel opaque. Matte white paint. RF = 67%.

Figure 5. Four different materials or finishes have been used for the center panels of these louverall ceilings. With film exposure identical for each photograph (1 sec. at f.22) note differences in cell brightnesses.

translucent material the same as the remainder of the louverall ceiling. While there is some variation in brightness across the ceiling, the general appearance is one of smoothness with the cellular pattern predominate. In photograph "B" the center panel has had etched aluminum louvers substituted for the translucent louvers. Immediately noticeable is a prominent streak of relative darkness down the center of the louver panel. This is characteristic of any louver material which is not translucent and which must depend only on direct and reflected light for the illumination within each individual cell. Photographs "C" and "D" in Fig. 5 illustrate opaque louver panels finished in white paint and placed in the center of the translucent louverall ceiling. Here again are found considerable variations in average cell brightnesses.

Brightness

In the past, with a little experience, a person was able to judge the illumination level within a few per cent by casual observation. These same persons consistently judge the level of illumination provided by louverall systems to be much lower than that actually measured. This would indicate that judgment was influenced by, and made from, the brightness of the lighting system rather than the illumination on the working plane. The apparent brightness of a louverall system being considerably lower causes the observer to estimate low.

It would doubtless prove of interest to include in this paper something on brightnesses and "glare ratings." Fig. 6 is a photograph of a grade school classroom with a louverall lighting system using translucent louvers. Pertinent room data are as follows:

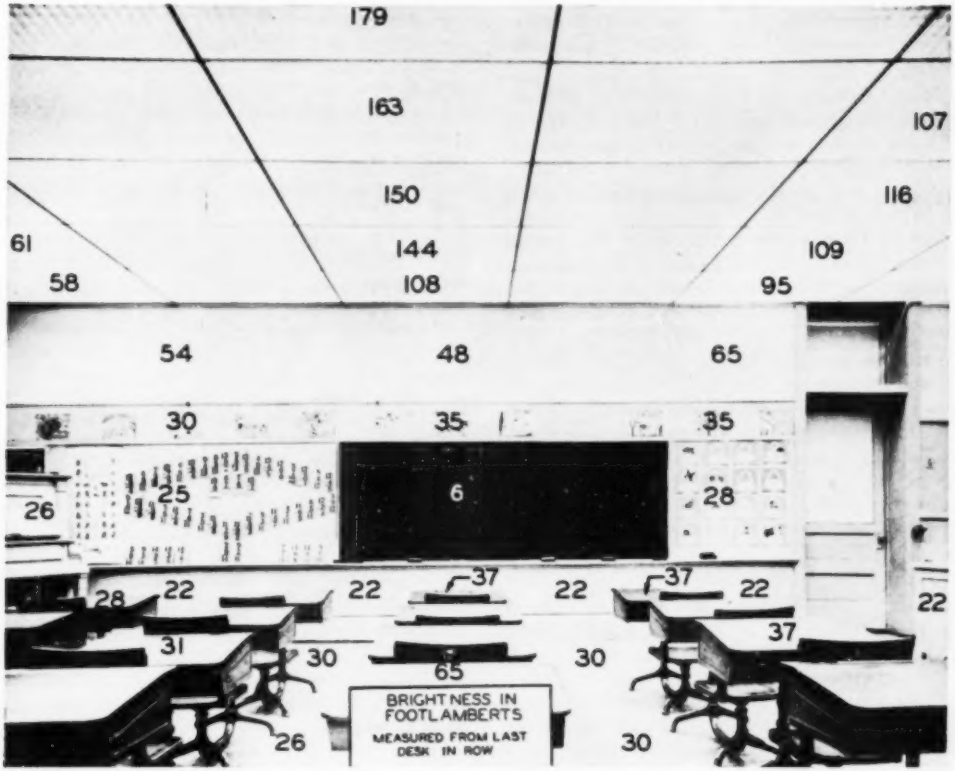
Room dimensions—25′ x 32′

Distance from the floor to bottom of the louvers—9′-9″

Distance from the top of the louvers to the bottom of lighting equipment—19″

Reflection factor of the lighting recess—80 per cent

Figure 6. Grade-school classroom with translucent louverall ceiling, showing brightnesses in footlamberts as measured from observer's position at last desk in row.



Reflection factor of the upper walls—60 per cent

Reflection factor of the lower walls—30 per cent

Reflection factor of the floors—43 per cent

Reflection factor of the desks—15 per cent

Lighting equipment—continuous rows of two-lamp 40-watt fluorescent RLM reflectors mounted 3 feet between rows. 4500° white lamps.

The average initial illumination at 100 hours of burning was 116 footcandles measured at desk height. Wall brightnesses were measured prior to the mounting of the pupils' art work. Ceiling brightness readings are average for their respective panels. For purposes of clarity many of the readings were purposely omitted from the photograph, and other readings were taken that were outside the camera's range.

Basing the calculations on Harrison's Glare Rating Formulas[3, 4] the glare rating for this room is found to be 6. A statement of a bold figure "6" means very little to a person not acquainted with Harrison's Glare Ratings. To provide a yardstick for orientation purposes the following quotation is taken from the Illuminating Engineering Society's *Lighting Handbook:* "In offices, drafting rooms, schoolrooms and similar locations glare ratings of less than 15 are considered to indicate comfort. . . ."

In any discussion of school lighting the question of reflected glare arises. The *Lighting Handbook* of the I. E. S.[5] limits the maximum zonal brightness in the vertical-45° zone (that zone contributing to the brightness of specular reflections or reflected glare) to 1000 footlamberts. Frankly, the school lighting installation shown in Fig. 6 does not meet this recommended limit, as the maximum brightness in the vertical to 45° zone is in the neighborhood of 1800 footlamberts (1640 footlamberts for the 40-watt 4500° white fluorescent lamp plus an increase due to interreflections). Let us remember, however, that the *Lighting Handbook* also states that the recommended level of illumination for classrooms is 30 footcandles maintained. Certainly increasing the general illumination will permit some increase in the vertical to 45° zone without lowering the brightness contrast. Just how much an increase this can be is worth investigating.

Fig. 7 is a chart showing a family of curves representing per cent brightness-contrast plotted against illumination in footcandles for various source-brightnesses. This chart is based on a study by Luckiesh[6] using a visual task of glossy ink (SRF—1 per cent, DRF—3 per cent) on glossy paper (SRF—1 per cent, DRF—80 per cent), source brightnesses of 100 to 800 footlamberts and illumination levels of 1, 10 and 100 footcandles. Since source brightnesses of over 800 footlamberts were not indicated the liberty was taken to extrapolate additional curves for 1000, 1500 and 1800 footlamberts.

Assuming that the recommended classroom level of illumination is based on a 75 per cent maintenance factor, the initial illumination level would be 40 footcandles with the maximum brightness still 1000 footlamberts. According to Fig. 7 this would result in a 74 per cent brightness-contrast for a visual task as mentioned above. Since the schoolroom pictured in Fig. 6 has an initial level of illumination of 116 footcandles a maximum brightness in the vertical-45° zone of 1800 footlamberts would give somewhat better than a 78 per cent brightness-contrast—a more favorable seeing condition than that offered by 40 footcandles initial (30 footcandles maintained) and 1000 footlamberts in the vertical to 45° zone.

An additional proof is indicated for the above reasoning by Commery[7] in a study of brightness-contrast against ratios of light-source brightness to incident illumination using ordinary black ink (SRF—0.9 per cent, DRF—2.7 per cent) on medium glossy paper (SRF—0.6 per cent, DRF—78 per cent)—a slightly different task than used by Luckiesh. According to this information a level of 40 footcandles and 1000 footlamberts maximum in the vertical to 45° zone would result in a brightness-contrast of about 73 per cent. A level of 116 footcandles and a brightness of 1800 footlamberts would give a brightness-contrast of about 81 per cent.

Pursuing this proof still further let us call into use a formula set forth by Crouch[8] regarding reflected glare.

$$C = \frac{(B_i + B_{iS}) - (B_z + B_{zS})}{B_i + B_{iS}}$$

where C = actual contrast seen by the observer
B_i = diffuse brightness of the background
B_{iS} = brightness specularly reflected from the background
B_z = diffuse brightness of the object
B_{zS} = brightness specularly reflected from the object

Assuming the use of black ink on white paper comparable to those used by Commery and substituting in the above formula we again find that 40 footcandles and 1000 footlamberts results in a brightness-contrast of 73 per cent while 116 footcandles and 1800 footlamberts gave a brightness-contrast of approximately 81 per cent. Though the results determined from the methods of both Commery and Crouch were identical, no indication has been discovered that their methods were identi-

cal. The above indicates definitely that with higher levels of illumination higher brightnesses than 1000 footlamberts can be used in the vertical to 45° zone. It also indicates that increasing this brightness to 1800 footlamberts at 116 footcandles compares favorably with the recommended maximum zonal brightness limits for classroom luminaires weighed against recommended illumination levels for classrooms as appearing in the *I. E. S. Lighting Handbook.*

In conclusion again consider the four basic considerations of the louverall lighting technique:

1. Adequate shielding
2. High system efficiency
3. Pleasing apeparance
4. Minimum direct and reflected glare

The significance of each of these points weaves itself so firmly into the pattern of quality louverall lighting design procedure that to neglect any one feature would be to compromise visibility.

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DISCUSSION

WILLIAM G. DARLEY*: The presentation of Mr. Benson's report on the tests on louverall ceilings seems to me to be a step in the direction of a more professional basis for our Society. Since there are so many features of the report which I think are excellent and so few which I think could stand improvement, my comments will be confined largely to suggestions which would, if adopted, improve the report from the engineer's viewpoint in my opinion.

It would be helpful to have specific values given for the test results on the charts and/or in the text. It would also be of value to have a more complete report on the effect of finishes. For instance, it would make the report more useful if results were included for opaque louvers having a matte white finish with a reflection factor of 90 per cent.

I do not believe that the "compromise" 45 degree shielding angle provides "*adequate shielding.*" Even on the narrow basis of visual acuity tests, a 45 degree angle is not adequate as is pointed out in the "close" of the paper "Applied Brightness Engineering from the Consulting Engineer's Viewpoint."[1] And when all of the psycho-physiological aspects of seeing are considered, the term "adequate" can not be applied properly to any shielding angle less than 60 degrees or greater. Extrapolations based on the original data forming the basis for part of the paper "The Design of Luminaires for Fluorescent Lamps"[2] indicate that for the "Direct Glare, Seated (Office Condition)" (Fig. 7 of paper), shielding for both lengthwise and crosswise viewing would have had to be between 60 and 70 degrees for all of the observers to have judged the condition to be "comfortable." On the other hand, I agree that today a 45 degree shielding angle is a reasonable compromise, even if it is not adequate. I only wish that more fixture manufacturers would feel this way about it.

It is agreed that Table 10-13 in the IES Handbook[3] is meaningless unless related to a specific brightness for a specified group of tasks. Mr. Benson's derivations with regard to higher brightnesses in the reflected glare zone are in agreement with the subjective appraisals discussed[4] at the New Orleans Conference. On the other hand, the maximum brightness of 452 ft-L in the 90-45 degree zone would appear to leave something to be desired.

In conclusion, I think that the louverall idea is very good and is a step in the right direction. But let us not make the oft repeated mistake[5] of accepting a step in the direction of our ultimate goal of Best Light as the goal itself.

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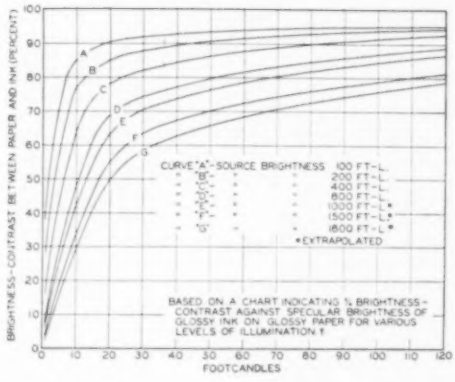
Figure 7. Family of curves representing per cent brightness-contrast plotted against illumination in footcandles for various source brightnesses.


BRIGHTNESS-CONTRAST BETWEEN PAPER AND INK (PERCENT)
FOOTCANDLES
CURVE "A"-SOURCE BRIGHTNESS 100 FT-L.
" "B" " " 200 FT-L.
" "C" " " 400 FT-L.
" "D" " " 800 FT-L.
" "E" " " 1000 FT-L.*
" "F" " " 1500 FT-L.*
" "G" " " 1800 FT-L.*
*EXTRAPOLATED
BASED ON A CHART INDICATING % BRIGHTNESS-CONTRAST AGAINST SPECULAR BRIGHTNESS OF GLOSSY INK ON GLOSSY PAPER FOR VARIOUS LEVELS OF ILLUMINATION †

*Consulting Engineer, Austin, Texas.

WILLARD C. BROWN*: I am glad to see this sort of work reported. The popular interest in louverall and its advantages in producing high levels of illumination with an unusually high degree of comfort make it desirable to have adequate data available on the various forms of this relatively new type of lighting.

Our studies support Mr. Benson's conclusion that a shielding angle of at least 45° is desirable where critical seeing is performed over a long period such as in offices, schools, and drafting rooms. About this same degree of shielding seems to be required for effective concealment of lamps and other objects above the louverall grid. We have one office installation with somewhat less than 40 degrees shielding, and the opinion of most people who have inspected it is that they are too conscious of what is going on above the grid. They would prefer more shielding.

There are of course many installations where less shielding is either acceptable or desirable. Particularly in stores, vertical illumination and utilization may outweigh the factors of concealment and brightness control. From Mr. Benson's data, it is apparent that translucent materials may permit use of a greater shielding angle for a given component of vertical illumination. He reports a loss of only 13 per cent in utilization when the shielding angle of the translucent louvers he used was increased from 30° to 45°. From our studies, with opaque white louvers a loss of about 22 per cent would be expected for the same increase in shielding angle from 30° to 45°. It is a logical conclusion that not only utilization, but also vertical illumination, is less sensitive to shielding angle with translucent than with opaque white louvers.

Appearance appraisals reported by Mr. Benson indicate a preference for 2″ x 2″ square cells. At present, cell sizes of this order are popular, but I doubt if appearance preferences can be limited to any one size or pattern. At Nela Park we have experimented with other sizes and also other shapes. It is our conclusion that larger cells can be acceptable in many instances and that there is considerable merit in, for example, the hexagonal and "sine wave" patterns. They eliminate much of the need for accurate blade alignment. On the other hand, very small cell size results in a textured effect rather than a bold pattern, and this is preferred by some people.

Mr. Benson's evaluation of the seeing conditions accompanying the louverall system he has described is worthy of particular attention. He compares the brightness contrast of a printed page when illuminated to 40 footcandles by 1000 footlambert sources and to 116 footcandles by lamps of 1800 footlamberts brightness. The former lighting practice conforms to the recommendations of the American Standard Practice of School Lighting, while the latter arrangement is the louverall system described by Mr. Benson. When ink and paper have the same specular reflectance, he shows that brightness contrast values are comparable with these two lighting systems. Under the louverall system, however, absolute brightnesses are higher and a comparison on the basis of visibility levels is even more impressive. The 40 footcandle system would provide a Relative Visibility level of 9 (on the scale of the Luckiesh-Moss Visibility Meter) assuming a detail size of four minutes, while the second would give a Relative Visibility level over 20.

The equation which the author credits to Crouch is basic for the calculation of brightness contrast. It is noteworthy that if the specular reflectance of the ink and paper are equal, brightness contrast cannot be reduced to zero regardless of the source brightness which may be imaged by the task. However, one of our investigations showed that a typical matte white paper had a specular reflectance of about 0.3 per cent while dull black printing ink ran about 0.6 per cent. Under these conditions, a source image in the ink impression can become as bright as the paper, thereby making the printing practically invisible.

One should use discretion in making calculations based on "nominal" values of specular reflectance since this factor varies with the angle of incidence and also with details of source, size and distance. Brightness contrast should be calculated only for application conditions closely approximating those under which the reflectance was determined.

Lamp reflections on the improved school desk tops should cause little or no interference with seeing. The flat finishes being given today to light-colored desks have a specular reflectance of about three per cent. The lamp images are well "fuzzed" and add about 50 footlamberts to the brightness developed by the 116 footcandles. The desk brightness, where these lamp images fall, will be on the order of 90 footlamberts, or just about the same as white paper.

I am glad to see that Mr. Benson has calculated the glare rating of his schoolroom according to the new Harrison-Meaker System. We feel that there is great merit in this system in its ability to predict in advance the general comfort of the installation from the standpoint of direct glare. As Mr. Benson points out, a rating of 6 for this room indicates a very good degree of comfort, and that is just what a good louverall system such as this one provides.

FRED J. VORLANDER**: Mr. Benson's paper has added interesting and much needed data to the existing knowledge of a desirable lighting technique that is rapidly increasing in popularity. Fig. 2 indicates that a lighting system having a louverall ceiling of 2″ x 2″ vinyl chloride acetate cells having a shielding angle of 45° will be 82 per cent as efficient as the same system with no louvers. The values shown in Fig. 2 relate to a lighting system using RLM fluorescent lamp reflectors. As many louvered ceiling installations have been and will be made with bare fluorescent lamps, it would be interesting to know how closely the values of Fig. 2 apply to bare lamp installations above louvered ceilings.

Men who design, sell, buy or maintain lighting systems have raised questions which have an important bearing on the progress of this lighting method. Comments by the author would greatly clarify the following questions:

1. How does a louverall ceiling affect the water distribution and effectiveness of a sprinkler system? Have insurance companies or fire inspectors approved or placed restrictions on such installations?

2. When R40 or PAR38 lamps are mounted above the louvered ceiling for accent lighting in merchandising areas or in show windows, how close can such lamps be mounted to the louver with safety?

3. The recommended method of cleaning louverall panels is to dip them in a soapless detergent. How much time must the maintenance people allow between dipping and replacing to avoid water dripping? What is the estimated time per square foot required for cleaning the louverall ceiling, not including lamps and fixtures?

M. N. WATERMAN**: This is a straight-forward paper providing useful information for the given conditions which are carefully stated.

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*Champion Lamp Works, Lynn, Mass.
**Westinghouse Electric Corp., Bloomfield, N. J.

I should like to make a friendly protest against the rather free use of the term "efficiency" as used on pages 4 and 5 of the preprint. The author is correct since he employs a center heading, stating that he is talking about system *utilization* efficiencies. Using the word "efficiency" in this sense, the paper, in giving results of tests of the several louver systems in a particular room, states that one system is more efficient than another because it gives more footcandles. My point is that I think we are getting away from the idea of stating that one lighting system is more efficient or less efficient than another on the basis of footcandles alone. This is because in appraising lighting systems we want always to give maximum room for the recognition of quality factors. Therefore, just as a matter of word usage, I think the term "utilization" is to be preferred to the term "efficiency" for this part of Mr. Benson's exposition.

The author does well to call attention frankly to the problem of reflected glare. Where this is a problem, Messrs. Potter and Oetting in their paper on louverall systems (January IE, 1949) have pointed out that a solution can probably be found either by tilting the louver blades, by reducing the source brightness, or both. For further valuable discussion of reflected glare from louverall or similar systems, those interested will profit from reading Ward Harrison's paper delivered before the British Illuminating Engineering Society last summer.

BENJAMIN S. BENSON, JR.*: The comments of Mr. Darley, Mr. Brown, Mr. Vorlander and Mr. Waterman are highly appreciated and reflect the great amount of interest shown louverall lighting by the lighting industry.

In reply to Mr. Darley, I realize that many more louver finishes, time permitting, might have been included. Testing opaque louvers having a matte finish with a reflection factor equal to the combined reflection and transmission factors of the translucent material would have been of scientific, if not professional, interest. The finishes tested were, however, representative of those in use today.

The maximum brightness figures given for the 45° louvers were found to occur, in every instance, just at the angle of cut off. The brightness drops off rapidly as the viewing angle approaches the horizontal. In the case of the translucent louverall, for instance, it was found that at a viewing angle of 15° above the horizontal, the maximum brightness was down to 176 footlamberts. The fact that it is possible to use a wide variety of light sources and equipments above louverall permits a wide range of louver brightnesses as well as brightnesses in the vertical-45° zone.

Mr. Brown raises an interesting question on the effect of cell size on maintenance. If the louverall panels are not removable, heavy in weight, or of such nature as to require wiping down or repainting, a cell opening larger than 2 inches is desirable from the standpoint of maintenance. With the plastic louver described in this paper, cleaning is performed by removing the panel and immersing it in a mild solution of lukewarm soapless detergent. It is not necessary to insert cleaning rag or paint brush into the cells. Consequently cell dimensions can be of any size desired.

Fig. 7 was based on a study by Luckiesh in which he happened to use glossy ink on glossy paper, both having a specular reflection factor of one per cent. It is unfortunate that the introduction of data according to Commery and Crouch gave Mr. Brown the impression that over-emphasis was being placed on the difficulty of brightness-contrast computations. This data was introduced for the purpose of substantiating my rather bold extrapolations of Luckiesh's data from a source brightness of 800 footlamberts to 1800 footlamberts.

In reply to Mr. Vorlander, there is no indication at the present time that the results shown in Fig. 2, since they are expressed *only* in *per cent footcandles in terms of no louvers*, would be appreciably different if bare fluorescent lamps were used.

To determine the effect of louverall, such as described in this paper, upon the water distribution and effectiveness of automatic sprinklers, a series of tests were made by a qualified laboratory[1] at louver distances of 18, 30 and 48 inches below a smooth ceiling. Reflectors used were of the fluorescent RLM type. I quote from their report,[2] "The difference in the distribution characteristics of automatic sprinklers when installed over Sky-Glo or other similar false ceiling materials is not of sufficient importance to affect appreciably the protection as a whole, when used for *light hazard occupancies* in non-manufacturing areas."

Translucent louverall is not recommended for use where ambient temperatures exceed 125°F. Tests show that where the ambient does not exceed 90°F, a PAR-38 150-watt projector spot lamp may be installed 18 inches above the louverall. In show windows, where a great many lamps of this type might conceivably be used, care should be taken that the total wattage in the area does not raise the temperature higher than the limit stated above. To avoid unsightly splashes of light on the louverall it is recommended that a gimble-type mounting be used which can be easily inserted right at the louver level to give a more tailored appearance. In some instances accent lighting is achieved by small spot light units mounted below the louverall with the stem support passing through one of the cell openings. This affords the merchant a practically limitless number of locations for his accent lighting equipment.

In answer to Mr. Vorlander's question concerning the cleaning of the louver panels, it is recommended that after dipping the panel, it should be shaken to remove excess moisture — after which it may be reinserted in the supporting frames.

I am sorry that I have no information available concerning the amount of time per square foot required for cleaning louverall. I am positive that such information, if available, would include the lamps and fixtures as well, since it would be uneconomical to clean the louverall without cleaning the lamps and fixtures also. Our experience has shown that the louvers in the louverall system require less cleaning than the lamps above them.

Mr. Waterman's comments are received in the spirit in which they were given.

*Author.

[1]Factory Mutual Laboratories (under the direction of the Inspection Dept., Associated Factory Mutual Fire Insurance Companies).

[2]Laboratory Report No. 11499, May 26, 1948.

Some Factors Affecting the Life and Lumen Maintenance of Fluorescent Lamps

By ERWIN F. LOWRY
ERIC L. MAGER

IN AN electronic tube or lamp the purpose of the cathode is to furnish electrons whose passage to the anode constitutes over 90 per cent of the electrical current carried by the device. Proper design of such a cathode demands that these electrons be furnished as economically as possible. In most electronic equipment the cathodes are of such a size and heated to such a temperature that most of the electrons required are emitted thermionically. This heating is usually done by means of a separate heating circuit which has no other function than to supply the energy needed to "boil" the electrons out of the cathode surface.

In the case under consideration we are confronted with a different situation. The fluorescent lamp operated on alternating current makes a number of rather specialized demands on its cathodes:

1. The structure serving as cathode does so only one-half the time. The other half of its operating life is spent in acting as anode.

2. This structure is heated to operating temperature during the anode half cycle by electron bombardment and is expected to have sufficient heat capacity to maintain operating temperature during the half cycle when it is performing its function as cathode.

3. The economics involved are such that only a fraction of the electrons are emitted thermionically. By far the larger portion are released as a result of positive ion bombardment or by the action of the electric field which in itself is affected by the presence of positive ions. Ordinarily this type of operation would result in very rapid erosion of the cathode surface by mercury ions, but the presence of an appreciable pressure of argon or other rare gas minimizes this action and permits an adequate cathode life.

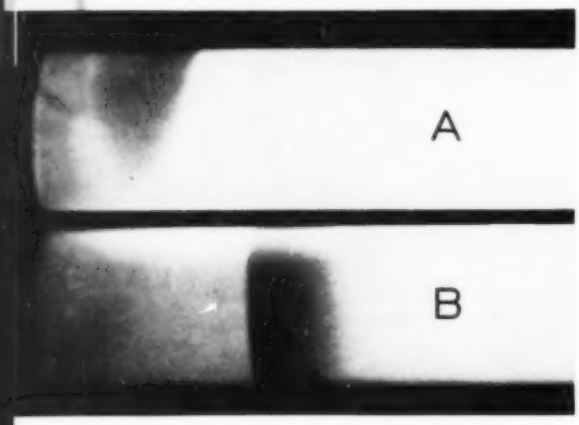


Figure 1. Photograph of typical anode spot and end band. A. Anode Spot; B. End Band.

The most satisfactory type of cathode so far developed for this service is a coiled coil of fine tungsten wire coated with an "emission mixture" of alkaline earth oxides generally including barium oxide. This coating usually fills the primary coil without "bridging" the turns of secondary coiling.[1] It is common practice, as it has been for many years in the radio tube industry, to apply this coating as a suspension of alkaline earth carbonates in a nitro-cellulose lacquer. By proper heating, the lacquer is vaporized and the carbonates converted to oxides during the evacuation process.[2] Proper processing results in the formation of a small amount of metallic barium which, actually, is the true source of the emitted electrons. As the lamp is operated, the oxide coating is gradually consumed, much as is the active material in a 4th of July sparkler. Normal failure of the lamp occurs when all the coating is gone.

This type of cathode and method of operation have proved to be very satisfactory but do have certain disadvantages.

In spite of the protective action of the rare gas filling, a certain amount of cathode sputtering or erosion as the result of positive ion bombardment is unavoidable. Cold or instant starting accentuates this erosion during the brief time required for the cathode to come to operating temperature each time the lamp is started. The effectiveness with which the coating resists this erosive action determines the life of the lamp.

A paper presented at the National Technical Conference of the Illuminating Engineering Society, Boston, Mass., September 20-24, 1948.

DR. LOWRY and MR. MAGER are with the Sylvania Electric Products Inc., Salem, Mass.

The decomposition of the cathode coating resulting from ion bombardment or the presence of trace amounts of certain impurities also results in two well known types of appearance defects. Photographs of typical examples of these discoloration defects are shown in Fig. 1. They are quite different in appearance and are caused by diametrically opposed mechanisms. In order to distinguish readily between these two types of discoloration, we have given them the names "anode spot" and "end band" respectively and have assigned factor of demerit values in arbitrary units depending on density. Both types of discoloration are very sporadic in their appearance.

The Anode Spot

This diffuse dark spot can readily be shown to be a deposit of metallic barium or other alkaline earth metal. It always appears directly adjacent to the coated electrode. In the great majority of lamps, it does not appear at all but when it does, it is usually early in life and does not increase in density after about 500 hours of lamp operation. It has been called an "anode spot" for the simple reason that if the lamp is burned on d-c, it invariably appears at the anode end of the lamp. Excessive preheating currents also are responsible for this appearance defect. The mechanism responsible for the anode spot is rather simple. As stated previously, the presence of a small amount of metallic barium in the cathode coating is necessary for efficient operation. Some barium is formed during the activation process carried out while the lamp is being exhausted. This barium formation is assisted by the reducing action of the tungsten core. If the tungsten is perfectly clean and free of oxide and the activation process is carried a trifle too far either during exhaust or early life an excessive amount of barium will be formed. If for any reason the electrode is now heated above a very low red heat, this excess barium will vaporize as barium atoms which then condense on the nearest portion of the lamp wall and the anode spot results. During normal lamp operation an equilibrium situation is established and the vaporization of barium ceases. The anode spot therefore usually does not increase in density after a few hundred hours of operation. The anode spot has no appreciable effect on the life of the lamp nor on its luminous efficiency. It is purely an appearance defect.

The End Band

The end band has the characteristic appearance illustrated in Fig. 1 and always appears at a definite position in the lamp. The edge of the band nearer the cathode is sharply defined but has a diffuse boundary toward the body of the lamp. The sharp edge always occurs at the end of the positive column as can readily be demonstrated in a set of clear (no phosphor) lamps with varying fill gas pressure. With high pressure the end of the positive column is much nearer the end of the lamp than in lamps filled to lower pressures. The location of the sharp edge of the end band follows these variations in position of the end of the positive column. This discoloration first appears as a faint brownish yellow ring which is just visible upon close inspection. With continued operation it continues to grow in density and to increase somewhat in width toward the body of the lamp, finally becoming quite black in extreme cases. Most of this discoloration may be removed by gentle heating, leaving behind the yellow ring which appeared originally.

As a rule, the formation of end bands indicates a somewhat shorter lamp life, particularly if the banding is severe. It must be emphasized that banding is not the cause of shorter life, simply that the same set of conditions which shorten lamp life are also responsible for end banding. It

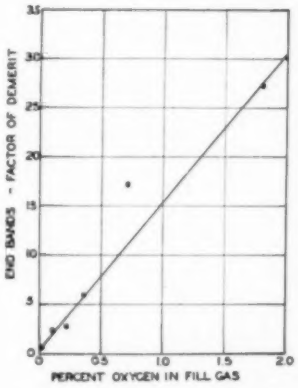


Figure 2. Curve showing the factor of demerit for end bands as a function of the percentage of oxygen in the rare gas filling of the lamp.

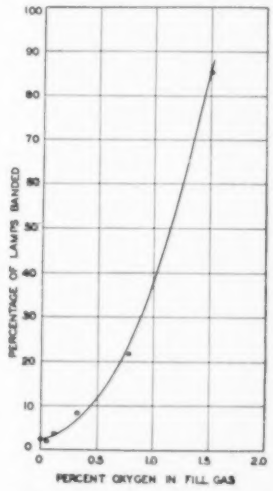


Figure. 3. Curve showing the percentage of lamps banded at 875 hours as a function of the percentage of oxygen in the fill gas.

should likewise be emphasized that lamps have been tested which had very long life in spite of conditions which caused rather severe banding early in life. Heavy bands obviously will have an adverse effect on lumen efficiency.

A careful series of experiments have been carried out to determine the nature of this band. In one experiment several groups of lamps were made up containing various percentages of oxygen in the fill gas. These lamps were then life tested. After 875 hours' burning all the lamps were inspected and factors of demerit in arbitrary units assigned to the end bands present. The result of this test is shown in Fig. 2. It is apparent that if no oxygen were present the end banding would also be practically absent at least at 875 hours.

The sporadic nature of the occurrence of these discolorations is well illustrated by Fig. 3, which shows how the frequency of occurrence of end bands increases rapidly with increasing amounts of oxygen in the lamp. The factors of demerit plotted in the various graphs of this report take into account both the density of the individual discolorations and the frequency of their appearance.

Figure 4. Photograph showing the intensity of end banding as a function of the oxidation of the tungsten cathode coils.

In another test the tungsten coils with which the cathodes were to be made were oxidized by heating in air for 15 minutes. Several such groups were so treated at different temperatures to obtain varying amounts of oxidation. These coils were then mounted, coated with the standard emission mixture and made into lamps. After life testing for 875 hours representative lamps from each group were photographed as shown in Fig. 4. The figures marked on the lamps are the temperatures Fahrenheit to which the tungsten coils were heated prior to processing. It is obvious from an inspection of this photograph that the density of the end banding is some function of the heating temperature and, therefore, of the amount of oxidation of the tungsten. Fig. 5 is another way of showing the same thing, viz., that the sufficient condition for formation of end bands is an oxidized cathode coil. Tests of this type have been performed many times and always with similar results. There is much other evidence of a like nature which indicates that the presence of a trace of oxygen in the lamp will result in the formation of bands. Further, analysis of the bands themselves shows that they are composed of a mercury oxide and mercury.

In the tests just described conditions were set up to promote the formation of end bands. These appeared earlier in life and were in general more intense than those met with in commercial lamps.

As a practical matter it is impossible to guarantee that no oxygen is present in the lamp made even under the most carefully controlled manufacturing conditions. It is, therefore, quite probable that the occasional early appearance of end bands is due to some situation such as those just described. The formation of these bands late in life is, however, undoubtedly due to the release of oxygen from the cathode coating. We have seen that the coating is gradually destroyed by the bombardment of mercury ions and that the tungsten core of the cathode acts as a reducing agent for the barium oxide, becoming itself oxidized as a result. Therefore, the mechanism is in existence for the gradual release of oxygen from the cathode coating and its reaction with mercury vapor to form the compound of which these bands are composed.

Remedial Measures

If this analysis of the various phenomena taking place at the cathode of the fluorescent lamp is correct, the problem facing the lamp engineer is to find some method of preventing or at least materially retarding this decomposition of the cath-

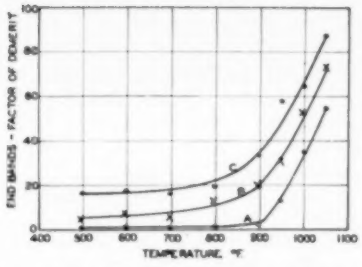


Figure 5. Curves showing the factor of demerit for end bands in arbitrary units as a function of the oxidation of the tungsten cathode coils. The amount of oxidation is that acquired by heating the coils in air for 15 minutes at the temperatures specified. A. Banding at 100 hours; B. Banding at 300 hours; C. Banding at 500 hours.

ode coating during operation of the lamp. Such a method has been found. It consists in a simple change in the composition of the cathode coating by the addition of a very refractory compound to the alkaline earth oxides. This new cathode coating has resulted not only in an almost complete elimination of anode spots during normal preheat operation but has materially delayed the appearance of banding, and it resists ion bombardment so well that lamp life has been considerably increased.

Fig. 6 is a "before and after" graph showing the decrease in anode spot formation in regular production 40-watt fluorescent lamps as a direct result of this change in cathode coating. During the first two months illustrated standard cathode coatings were used. During the ensuing two months, the new coating was employed. Twenty-four lamps from each day's production were burned for 300 hours and then examined for the presence of spots.

A factor of demerit in arbitrary units was assigned to each spot detected and the sum of all such factors divided by the number of lamp cathodes involved. The ordinates of the graph represent these average values. Since 10 was the value assigned to a barely visible spot and 80 to a heavy spot, the almost complete absence of spot formation with the new cathode coating is readily realized. The factor of demerit system described above has been our standard method of numerically evaluating fluorescent lamp discolorations for several years. The system applies to end bands the same as to anode spots except that a barely visible band is assigned a value of 20 and a very heavy band a value of 100.

A similar improvement in the formation of end bands also resulted from this change in cathode coating formulation. Fig. 7 is a photograph of two groups of lamps after 3000 hours of burning. These two groups are representative of the amount of discoloration to be expected after this period of operation with the new and the old cathode coating. The cathodes in the upper group of lamps were made with the new coating. The cathodes of the lower group were coated with the old standard emission mixture. The improvement is obvious.

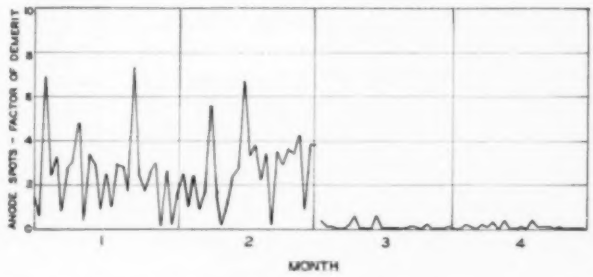
The photograph of a group of lamps shown in Fig. 8 is illustrative of the development of end discoloration at various burning hours using the new cathode coating. In this group of lamps, no appreciable discoloration appeared until about 5000 hours, after which it increased rapidly.

The new cathode coating has been found to have another important advantage. For a number of years, fluorescent lamp life has been rated at 2500 hours on a three-hour duty cycle. This has been a very conservative rating, at least under controlled test conditions. The shape of the mortality curve, however, has been such that as many as 25 per cent of the lamps may have failed at 2500 to 3000 hours. This early failure situation has been nearly eliminated by the use of the new coating. Tests in our laboratories on large numbers of lamps show less than five per cent failure at 3000 hours. The failures which have occurred have been, for the most part, mechanical and not the normal failure resulting from consumption of the cathode coating by erosion.

The Lumen Maintenance Problem

Now it is not sufficient to increase the life of a lamp and reduce the appearance of end discolora-

Figure 6. Graph illustrating the improvement in anode spot formation resulting from the use of an improved cathode coating.



tion unless that lamp also maintains its luminous efficiency throughout its increased life. In an article[2] published a few months ago, a series of curves were shown illustrating the improvement in lumen maintenance which has been accomplished by fluorescent lamps since the prewar years. These curves included one for some lamps made during January 1947 which showed a definite improvement over those of 1946. An equation was also developed which described rather well the lumen maintenance up to 4000 hours' burning time.

Additional data have been obtained on the lumen maintenance of 1947 lamps which further establish the improvement which was suggested in the earlier paper. This comparison is shown in Fig. 9. There is very little difference in the initial lpw figures for the two groups of lamps but the 1947 lamps have the same luminous efficiency at 4000 hours as the 1946 lamps did at 1750 hours. Due to lamp failure there is little data available for 1946 lamps beyond 4000 hours. The 1947 lamps, however, show a higher efficiency at 6000 hours than the older lamps did at 3000. This improvement is primarily due to one thing. In the 1947 lamps, a very small amount of antimony trioxide (Sb_2O_3) was added to the finished phosphor suspension just prior to coating the bulbs.

This addition to the phosphor was the only change in formulation or processing made at the time and is the factor responsible for the improvement. It had previously been found by Arthur Roy and Robert Ives of the Sylvania Engineering staff that this addition resulted in improved lumen values at 100 to 500 hours' burning time although it depressed the initial efficiency slightly. A great deal of work was done by various members of the engineering group to establish the validity of this discovery and to determine the reasons for the improvement.

It has been recognized for some time that lamps made with lead glass bulbs have better maintenance than those made with soda-lime glass. This difference is shown in Fig. 10. The data in the legend refer to the constants of the maintenance equation and will be discussed later. Fig. 11, Curve *X* demonstrates the results obtained by treating lime glass bulbs with a suspension of Sb_2O_3. In this experiment the bulbs were coated with the suspension, which was allowed to drain and dry. The bulbs were then baked just short of the softening point of the glass and then thoroughly washed in boiling water. The bulbs were then coated with standard white phosphor, made into lamps and life tested. A comparison of this curve with that for lead glass in Fig. 10 shows that the two groups of lamps have nearly equal initial and 4000 hour values of efficiency. Curve *Y* of Fig. 11 demonstrates that the further addition of Sb_2O_3 to the phosphor results in an additionally improved maintenance.

Other experiments have shown that sodium compounds have a deleterious reaction with the phosphor and that the addition of an antimony compound to the finished phosphor prevents or materially reduces this reaction.

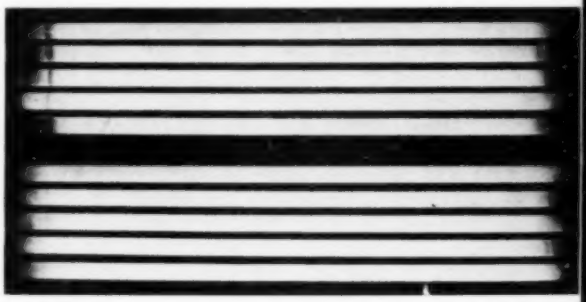
Experiment has also demonstrated that a thin film of Sb_2O_3 spread on ultraviolet transmitting glass reduces appreciably the transmission of 1849A radiation without seriously affecting the transmission of 2537A radiation.

In the paper previously referred to[3] it was suggested that the deterioration of the phosphor during operation of the lamp resulted from three independent reactions which proceeded with widely different velocities:

1. A rapid "gas phase" reaction resulting from combination of the phosphor with some gaseous impurity.
2. A "solid phase" reaction such as might occur between the phosphor and the glass.
3. A third, very slow deterioration of the phosphor, possibly resulting from absorption of energy from the discharge.

The additional evidence which has been obtained corroborates these assumptions. A further careful study of the maintenance curves made possible with the longer life lamps available, permits a revision in the maintenance equation which could only be hinted at in the earlier paper. Lumen measurements at 500-hour intervals on lamps burned for 8000 hours show that the long term decay in efficiency is not linear but is an exponen-

Figure 7. Photograph of two groups of lamps after 3000 hours' burning, end band formation resulting from the use of an improved cathode coating. Upper group, old cathode coating; lower group, new cathode coating.



tial function exactly similar to the first two terms on the righthand side of the equation. The revised lumen maintenance equation as determined from the best data now available is:

$$L_o - L_T = A\ (1 - e^{-aT}) + B\ (1 - e^{-bT}) + C\ (1 - e^{-cT})$$

where the exponents a, b, and c for 40-watt white lamps are 4.0, 0.2 and 0.02 respectively and A, B, and C have the dimensions of lpw.

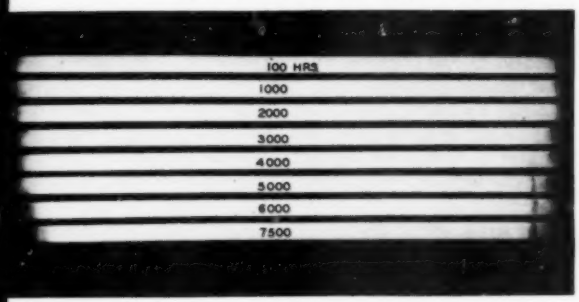
In the limit, *i.e.*, when all three reactions have reached completion, this becomes:

$$L_o - L_T = A + B + C$$

In mathematical language this equation says, very simply, that the luminous efficiency of a lamp does not decrease indefinitely but approaches a limiting value. The maximum efficiency in lpw which the lamp will lose no matter how long it is burned is equal to the sum of the three coefficients A, B, and C. For lamps such as those represented by Curve 1947 of Fig. 9, this means that they would have terminal efficiencies of about 40 lpw even if they lasted indefinitely.

The values of the coefficients, A, B, and C are given for the various curves in the legends included in the appropriate figure. An inspection of the values of these coefficients indicates that the chief effect of the antimony addition to the phosphor has been to decrease the amount of second term or solid phase reaction. To a lesser degree this addition has also decreased the coefficient of the third term, resulting in an improvement in the long term maintenance. Since antimony compounds are well known glass forming materials and the oxides vaporize at the baking lehr temperatures, it is quite probable that a thin protective coating is formed, which covers, or partially covers, the phosphor particles. If this protective film is spread over the surface of the bulb it protects the phosphor from reaction with the sodium compounds in the glass as demonstrated by Fig. 11. If it also is caused to cover the phosphor, it will protect the phosphor from damage by the 1849A radiation to which Meister and Nagy[4] attribute the major portion of phosphor deterioration.*

Figure 8. Photograph showing the development of end discoloration after various periods of lamp operation in lamps using the new cathode coating. The numbers on the bulbs represent the burning time in hours.



As a result of the improvements in lumen maintenance which have been achieved, the 40-watt fluorescent lamp which embodies these improvements has slightly better percentage maintenance at 1000 hours than a 40-watt incandescent lamp and a considerably better percentage maintenance than the larger sizes of incandescent lamp such as the 200- and 300-watt lamps. This percentage is based on the initial or 0-hour lumen values for all lamps. Fig. 12 shows some lumen maintenance curves for recent 40T12 3500° white fluorescent lamps and a few of the more common types of incandescent lamp.

Obviously the advantages to be gained from improved lamp performance are completely nullified if lamps and fixtures are permitted to collect dust and dirt without periodic cleaning at suitable intervals. The longer the lamps burn the more important this cleansing program becomes. The decrease in early failure combined with the improved lumen maintenance as accomplished by the improvements disclosed point toward the consideration of group replacement. This will assure the most effective utilization of the installation as a whole.

Summary

A brief outline of the construction and operation of the fluorescent lamp cathode has been given and a discussion of some of the defects appearing in the lamp which are connected with cathode behavior. A description of the "anode spot" and the "end band" has been given and some of the causes for their formation have been explained. It has been shown that the addition of a very refractory compound to the cathode coating will nearly eliminate the formation of anode spots and delay materially the formation of end bands. The same addition also improves the life of the lamp.

A further study of lumen maintenance has been carried out and the maintenance equation revised in the light of the additional information obtained. It has been discovered that the addition of a very

*The maintenance problem was discussed at some length by E. F. Lowry in a paper read before the American Physical Society at Madison, Wisconsin, June 22, 1948. This paper appears in abstract form in The Sylvania Technologist, Vol. 1, No. 3, July 1948.

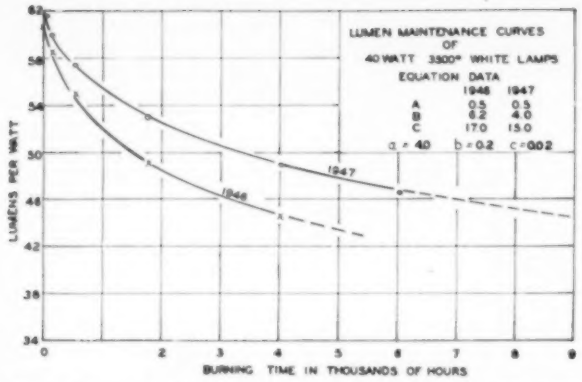


Figure 9. Lumen maintenance curves for some 40-watt 3500° white lamps showing the improvement resulting from the addition of Sb_2O_3 to the phosphor.

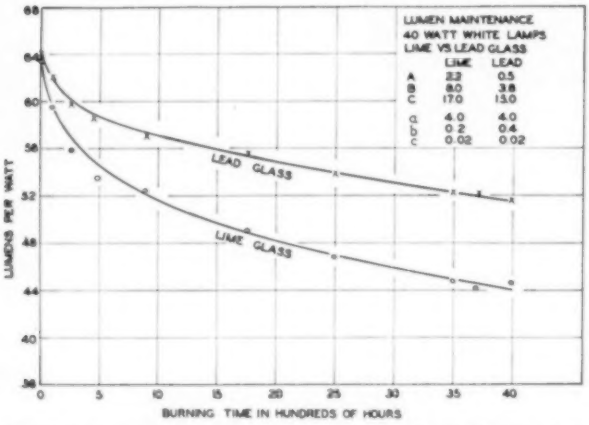


Figure 10. Lumen maintenance curves of 40-watt 3500° white lamps showing the difference in lumen maintenance depending on the type of glass used.

small amount of an antimony compound to the phosphor has a marked effect on the maintenance. This addition agent behaves as though it formed a thin protective coating over the phosphor particle, preventing its reaction with harmful ingredients in the glass on which the phosphor is spread and minimizing phosphor deterioration by absorption of high energy quanta in the mercury radiation. Graphs are shown giving the practical significance of these changes in lamp construction.

Acknowledgments

The authors wish to express their appreciation for the aid received from various members of the Product Engineering Department, Danvers, Mass., and from their colleagues in the General Engineering Department at Salem.

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2. McCulloch, Leon (to Westinghouse Electric and Mfg. Co.), U. S. Patent 1,695,899 (December 18, 1928).

3. Lowry, E. F.: "A Study of Fluorescent Lamp Maintenance," ILLUMINATING ENGINEERING, Vol. XLIII, No. 2, p. 141 (February, 1948).

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DISCUSSION

E. H. RADDIN:* The authors are to be complimented on their contribution. Dr. Lowry has presented two other very interesting papers at our Illuminating Engineering Society Conferences, one at Quebec and one at New Orleans, on the subject of the lumen maintenance of fluorescent lamps. This paper shows that his efforts have contributed to producing lamps of longer life and higher lumen maintenance throughout life and lamps with reduced end blackening.

Lamps of longer life without higher lumen maintenance might be of questionable economic value. It seems to me that the improvement obtained in lumen maintenance can be attributed to the scientific approach Dr. Lowry has used of separating the loss of lumens throughout life into three phases or burning periods with the idea of finding methods of manufacturing to reduce the loss of lumens in each phase. I do not know of any other publication showing this approach.

Referring to Fig. 12, the curve *D* shows that the best fluorescent lamps that were produced still lose about 15% in lumen output after burning 2000 hours. The question arises as to the probability of reducing this loss by the use of better materials and manufacturing methods.

Improvement in lumen maintenance during the life of incandescent lamps is not probable because the loss is due to the evaporation of the tungsten filament and until a better filament is discovered appreciable improvement in lumen maintenance is not expected.

The loss of lumens from fluorescent lamps during life is due to very different causes than in incandescent lamps. The more common explanation of the loss of lumens during the life of fluorescent lamps is the failure of the phosphor to maintain the initial lumens. This failure has been attributed to several causes among which are the properties of the phosphor materials, action of impurities in the lamp on the phosphors and action of the arc stream on the phosphors, particularly the 1850A line.

Experience in manufacturing fluorescent lamps is new

*Champion Lamp Works, Lynn, Mass.

compared with incandescent lamps and it is to be expected that further improvement in quality can be made.

GEORGE S. EVANS:* In this paper Dr. Lowry, with co-author Mr. Mager, has done his usual fine job of analysis and presentation. Two questions have occurred to me which I would like to ask the authors.

The authors state that instant starting accentuates cathode erosion each time the lamp is started. Lamps designed for instant starting are, of course, engineered to minimize this erosion. In the case of the slimline lamps, which combine small lamp diameter with instant starting, lamp deposits resulting from material eroded from the cathode would tend to be more pronounced than in larger diameter instant start lamps or in preheat type lamps. Did the authors find that the demerit system showed the slimline lamps to be worse offenders for lamp blackening?

The addition of a refractory oxide to the emission coating was shown to have two results—elimination of anode spots and delaying of the appearance of lamp banding. In eliminating the anode spots, the refractory oxide served to retain excess barium in the cathode. In retarding the formation of end bands, which are due to traces of oxygen in the lamp, it appears that the refractory oxide also acted as a getter for the oxygen. One can imagine a compound being formed which is strong enough to cause barium retention yet weak enough that the barium would be available to act as a getter for traces of oxygen. Would the authors care to hazard an explanation of the mechanism which gave the two desirable results?

E. F. LOWRY:** Cathode disintegration as the result of instant starting has been well recognized for many years. Gas filled diodes and thyratrons in general require the use of a time delay relay in the anode circuit to insure that the anode voltage is not applied until the cathode has reached operating temperature. The preheat starting of fluorescent lamps was designed to avoid this well known difficulty. It has recently become possible to design cathodes which will withstand this mistreatment remarkably well if the arc current is not too large. The sputtering or sparking of the cathode coating material is, however, always more severe than with preheat operation. In so far as the authors are aware, this cathode disintegration is a function of the size of the arc current rather than of the dimensions of the tube. In the case of the slimline lamps to which Mr. Evans refers, the chief difficulty is caused by the multiple ratings of these lamps. Cathodes engineered to function properly at a given current will tend to develop end banding if operated at currents which cause the cathode to run too cold. On the other hand, if the same cathode is operated at an excessive current, causing it to run too hot, an increase in anode spots will result. In order to secure optimum performance, any fluorescent lamps should be operated at or very close to the current for which the cathode is designed.

In answer to Mr. Evans' second question: An immense amount of data has been obtained substantiating the results reported in this paper. The authors have made no attempt to discuss any of this work other than to show the practical results obtained. This work is being continued and the authors hope to publish a complete report embodying both the practical and theoretical aspects of the problem at a later date.

*Westinghouse Electric Corp., Bloomfield, N. J.
**Author.

Figure 11. Lumen maintenance curves of 40-watt 3500° white lamps showing the effect of treatment with Sb_2O_3. *X*, glass treated with Sb_2O_3; *Y*, glass and phosphor treated with Sb_2O_3.

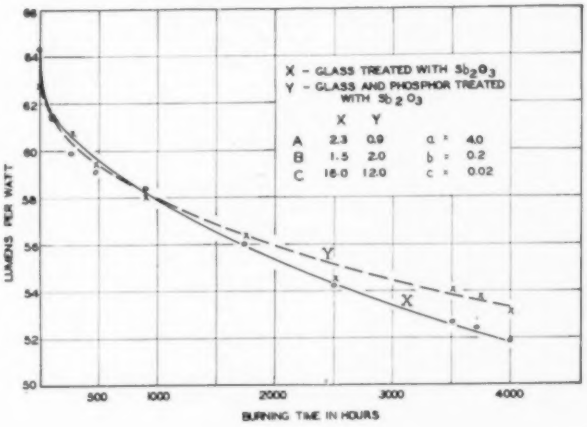
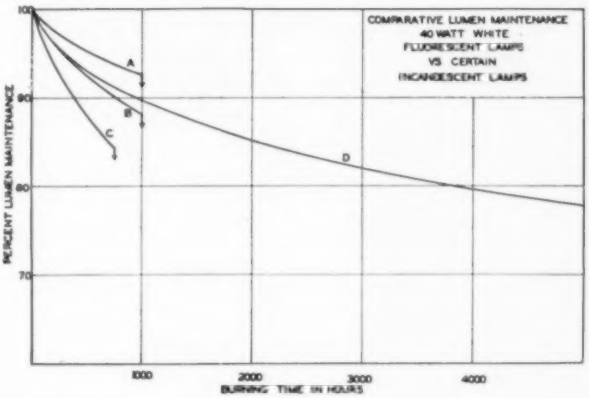


Figure 12. Curves showing comparative lumen maintenance of 40-watt fluorescent lamps and certain incandescent lamps. A. 60-watt incandescent; B. 40-watt incandescent; C. 200-300-watt incandescent; D. 40-watt white fluorescent.



Munsell Value Scales for Judging Reflectance

By NORMAN MACBETH

A report of the chairman of the I.E.S. delegates to the Inter-Society Color Council.

REFLECTANCE of colors is the concern of illuminating engineers, architects, and interior decorators as they plan efficient, useful, and aesthetically satisfying lighting installations. When plans for the I.E.S. Handbook[1] were first discussed, Dr. H. P. Gage — then chairman of Illuminating Engineering Society delegates to the Inter-Society Color Council — after consulting with the editors, initiated plans for developing a color chart that would contain a maximum of useful information on reflectance in a minimum of space. It was hoped by some that such a chart might be included in the Handbook.

Dr. Gage drew up tentative plans for a chart to contain high reflectance colors. From the beginning he sensed that the orderly arrangement in constant value levels of the Munsell colors[2,3,4] would provide for this purpose a directly applicable series of measured standards. For several years, with the cooperation of a few interested I.S.C.C. members and of Mrs. Blanche Bellamy of the Munsell Color Company, various forms of charts were made up. The work proceeded slowly because so many factors were involved that as each chart was produced, improvements suggested themselves.

In December, 1945 the writer became chairman of the I.E.S. delegates to the I.S.C.C. partly because Dr. Gage then had the hope that a new chairman might push the matter of a suitable reflectance chart to a conclusion in time for announcement in the Handbook. However, there were still many time-consuming factors to be taken into consideration. By this time it was realized by everyone concerned that a suitable series of measured colors would cost more than could be afforded for inclusion in the Handbook. This applied not only to Munsell charts, but to other methods of procuring suitable scales that were investigated by those interested. Therefore, Mrs. Bellamy assured the editors that if a form of chart suitable for I.E.S. use could be developed and ok'd, the Munsell Company would manufacture and make it available. At that time the form of chart shown in Fig. 4-5 of the I.E.S. Lighting Handbook was under discussion.

MR. MACBETH is Chairman of the I.E.S. delegates to the Inter-Society Color Council.

In July 1947, R. W. McKinley, Handbook editor, got in touch with the writer to ask if he—as chairman of I.E.S. delegates to the I.S.C.C.—could not bring the matter to completion. He in turn got in touch with Miss Dorothy Nickerson, secretary of the I.S.C.C., who by that time had begun to realize that if a satisfactory chart were to be developed, some one was going to have to do some concentrated work. It was realized that if I.E.S. members had not been able to provide blueprints for a suitable chart it was because so many factors had to be taken into consideration that they could not visualize a final chart that would cover the scope of their needs; if the Munsell Company was not able to provide blueprints it was probably because they were not sure just what minimum of color information would be most useful to illuminating engineers. Therefore, having done about as much work in color and illumination as anyone in the field, and feeling it an opportunity as well as an obligation to complete the work already well begun under I.E.S. auspices, the I.S.C.C. secretary took over responsibility for the work.

Three new sets of charts were developed. With Mrs. Bellamy's help they were made up in time for visual presentation as a basis for discussion with delegates to the I.S.C.C. present at the New Orleans meeting of the Illuminating Engineering Society in September, 1947. The suggestions and advice gained there, and the cordial cooperation of I.E.S. delegates in regard to the need and use for this type of color chart, provided the incentive for one more—and a final—revision that has resulted in the series of Munsell Value Scales for Judging Reflectance illustrated herein.

As the above history illustrates, the development of this chart for I.E.S. use is due to the cooperative effort of many persons, both in the I.E.S. and the I.S.C.C. For completion of these charts further cooperation was still necessary. The Munsell Company had to make up several new color standards on the very high reflectance level, the National Bureau of Standards cooperated by

completing spectrophotometric measurements on these new samples in record time, the U S. Department of Agriculture cooperated by computing the necessary colorimetric data.

Description of Scales

The scales consist of Munsell value scales in neutral grays, and in low chroma and maximum chroma for 10 hues. These are mounted on the edge of 11 pocket-size charts (8" x 2"), bound at the bottom so that they may be fanned out for easy selection of the nearest matching color for any wall or other surface in which there is interest.

Under each color chip is its Munsell notation. Opposite each chip are numbers representing per cent reflectance (%R) under three illuminants identified as *A*, *C*, and *S*. "A" represents I.C.I. illuminant *A*, a tungsten filament lamp operating at 2848°K; "C" represents I.C.I. illuminant *C* which is intended to represent average daylight at about 6700°K; "S" represents illumination from a completely blue sky in accord with calculations suggested by Gibson.[5]

Each of the 11 charts is covered with a cellophane envelope. This is used in order to avoid making finger marks on the color samples, but should be removed for final judgments of reflectance, after a preliminary investigation indicates which of the scales is to be used for this purpose.

The charts are provided in a case which contains masks of white, gray, and black, and a description of the charts and instruction for their use.

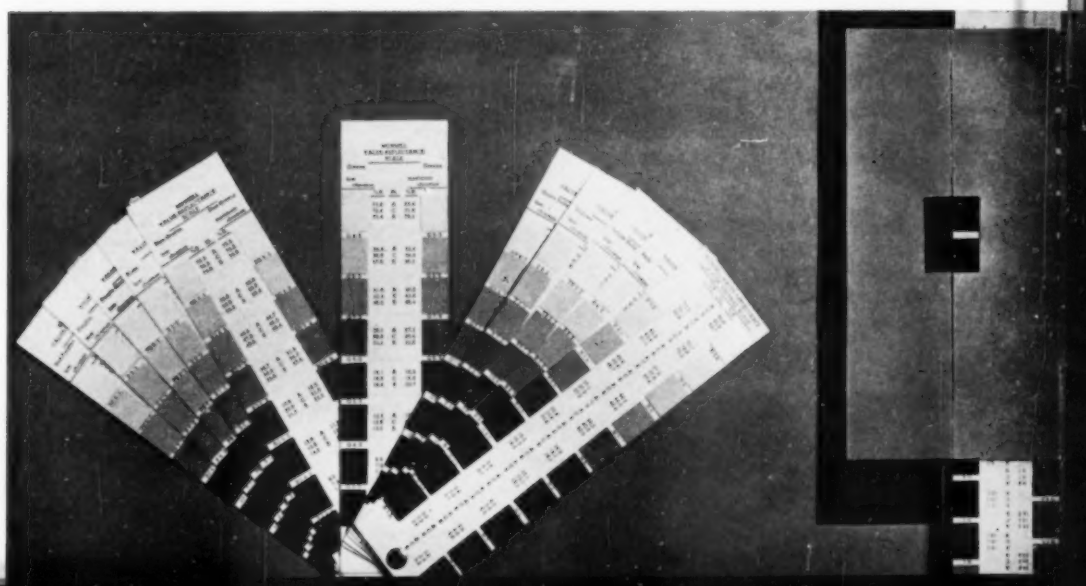
Use of Scales

On these few scales it is possible to display 189 samples. Since this is but a small fraction of the more than 1500 available Munsell standard papers, and an even smaller fraction of the million or more colors that the eye can detect, it is obvious that exact color matches cannot be made with these scales for all colors that the illuminating engineer, architect, or interior decorator may require.

However, the series should be adequate for many purposes, since it includes a 19-step neutral value scale, and both low and maximum chroma in nine values of ten hues. (Other scales, both regular and special, can be produced if further colors are required.)

For neutral colors there is little change in reflectance under different illuminants. As colors depart from gray, the spectral quality of the illuminant has an increasing effect on reflectance. Thus for low chroma (weak) colors the changes with different illuminants are slight, whereas colors of maximum chroma show the greatest changes, some hues changing more than others, depending both on the spectral quality of the illuminant and samples. The reflectances in these scales were obtained from measuremen's made at the National Bureau of Standards on . series of Munsell standard papers.[2] In some cases new paintings of Munsell samples have been substituted for those measured and reported, but in all cases the samples are close and since they are made with the same pigments the change reported under the three illuminants remains relatively the same. Usually when samples are measured on a spectrophotometer they are calculated and reported for only one illuminant. Reflectance measure-

Value reflectance scales fanned out to show individual color charts; demonstration of use of masks in finding the reflectance of a sample with these scales.



ments for more than one illuminant are at present available for only a very few samples other than the 425 Munsell standards measured at the National Bureau of Standards.[2]

To use the scales, fan them out without touching the color samples themselves so as to select the scale that displays the hue nearest to that of the sample to be judged. From that scale remove the cellophane envelope and choose the chroma most similar to the sample, placing the edge of the standard close to the sample. For the most accurate results, a mask—white for light colors, gray for medium colors, and black for dark colors—should be placed over the sample and the standard on the scale that most closely resembles it in lightness (value). The mask should be large enough to cover two standards, so that if the value of the sample falls between two standards it may be properly judged.

If the sample does not match one of the standards in value, decide which standard is closest, or whether the sample is halfway between two standards. Record the best judgment as to value, and the corresponding reflectance for the type of illumination closest to that under which the observations are made.

Supplementary Information

Munsell color standards[3] provide an orderly arrangement of reference colors which serve as guides for the measurement and notation of all colors. For daylight illumination they represent equal units of visual spacing of the three psychological attributes of color, which in the Munsell System are called *hue*, *value*, and *chroma*[4,6]. Hue is the name of a color, as red, yellow, green, or blue. Value is the brightness (lightness or darkness) of a color, ranging from white to black. Chroma is the saturation, or the strength, or purity, of a color as compared with a gray of the same value.

The Munsell attribute of value is directly related to reflectance. Much work has been done on this relationship, and the conversion table published in the final report of the Optical Society of America's Subcommittee on the Spacing of the Munsell Colors[7,8] is given in summarized form in Table I. The reflectance figures in the table, as well as those in the present color scales, are I.C.I. "Y" tristimulus values, "Y" in I.C.I. notation being equivalent to per cent reflectance. The full table published in the O.S.A.[7] and I.E.S.[8] reports contains conversions for value intervals of 0.01.

The figures in Table I follow theoretical spacing, while the data supplied for the standards on the charts are based on measurements of papers measured at the National Bureau of Standards. In practical work, as in the table, reflectance is usually expressed in terms of the reflectance of magnesium oxide (MgO), rather than in terms of absolute reflectance. The Munsell 10/ value, however, refers to Absolute White, and thus the value assigned to magnesium oxide is 9.9/.

Table I.—Conversion for Munsell Value to Reflectance. I.C.I. "Y" Equivalents (in per cent relative to MgO) of the Recommended Munsell Value Scale (V) from 0/ to 10/.

V	Y_Y(%)	V	Y_Y(%)
0/	0	5.0/	19.8
0.5/	0.6	5.5/	24.6
1.0/	1.2	6.0/	30.0
1.5/	2.0	6.5/	36.2
2.0/	3.1	7.0/	43.1
2.5/	4.6	7.5/	50.7
3.0/	6.6	8.0/	59.1
3.5/	9.0	8.5/	68.4
4.0/	12.0	9.0/	78.7
4.5/	15.6	9.5/	90.0
		10.0/	102.6

Colorimetric data have been recorded in I.C.I.[9] terms for about 425 Munsell standard colors under four illuminants:[2,10,11,12] I.C.I. illuminant *A*, a tungsten lamp at 2848°K; I.C.I. illuminant *C*, average daylight at 6700°K; *D*, Macbeth artificial daylight at 7500°K; and *S*, blue sky as computed from theoretical data. Similar data can be determined for any other light source whose spectral energy distribution is known. Reflectances for three types of fluorescent lamps are now under computation for the color samples on these charts. The spectral distributions for the fluorescent lamps have been made available through courtesy of the General Electric laboratories.

The scales described are now available direct from the Munsell Color Company, Inc., 10 East Franklin Street, Baltimore 2, Maryland.

References

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3. Munsell Color Company, Inc., *Munsell Book of Color*, standard library and pocket-size ed. Baltimore 2, Md. (20-hue chart ed. 1929; 40-hue chart ed. 1942).

4. Munsell, A. H.: "A Color Notation," Munsell Color Company, Inc., Baltimore 2, Md. (Ed. 9, 74 pp., illus., 1941.)

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6. Nickerson, D.: "Munsell Color System," ILLUMINATING ENGINEERING, Vol. XLI, 549-569, 1946.

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8. Nickerson, D.: "Spacing of the Munsell Colors," ILLUMINATING ENGINEERING, Vol. XL, 373-386, 1945 (table 1, pp. 376-379).

9. Commission Internationale de l'Eclairage, Proceedings of the Eighth Annual Session, 694 pp., illus., 1931, Cambridge, England.

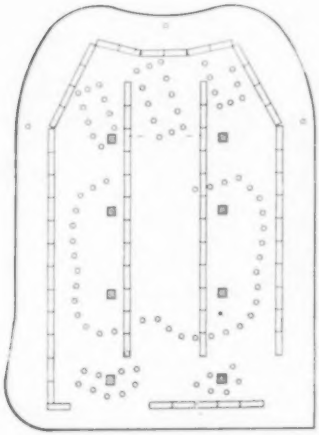
10. Nickerson, D.: "Munsell Colors Specified for Four Illuminants," ILLUMINATING ENGINEERING, Vol. XL, 159-171, 1945 (table 2, pp. 164-171).

11. Nickerson, D.: "Artificial Daylighting Studies," *Transactions*, I.E.S., Vol. XXXIV, 1233-1253, 1939.

12. Macbeth, N.: "Color Temperature Classification of Neutral and Artificial Illuminants," *Transactions*, I.E.S., Vol. XXIII, 302-324, 1928.

Lighting a Sports Shop

LIGHTING OBJECTIVE: To illuminate a sports shop to provide a pleasing merchandising environment and to highlight the merchandise for attention and appraisal.



Installation at Kleinhans Company, Main & Clinton Streets, Buffalo, N. Y.; Architects, Duane Lyman & Associates; Electrical Consultant, Edwin S. Burrows.

General Information: The room is 73 feet by 23 feet high with a 12-foot high ceiling. Flat light cream ceiling and upper walls provide approximately 77 per cent reflectance. The floor is a light patterned terrazzo and the woodwork is light.

Installation: General lighting is provided by the use of two-lamp fluorescent troffers with diffusing glass in continuous rows on 13 foot, 6-inch centers. The outside row follows the contour of the walls of the room. White fluorescent lamps (3500° 40-watt T-12) are used in Pittsburgh No. PF-248-GE two-lamp troffer units.

Local lighting over the counter cases is provided by incandescent louvered concentrating reflectors (Pittsburgh No. C-201-A-5)

(over)

A.I.A. File No. 31/14

with 150-watt inside frosted lamps 38 inches on centers over the customer's edge of the counter. Units follow irregular layout of the counters. Local lighting on the wall cases is provided by continuous white fluorescent lamps in "Grand Rapids Strip" which illuminate the stock and the walls above the cases. Display cases are illuminated with continuous white fluorescent lamps.

The lighting load consists of 3.2 watts per square foot from the incandescent downlights; 1.7 watts per square foot from the fluorescent troffers; 0.8 watts per square foot on the fluorescent strip lighting; the total being 5.7 watts per square foot.

Illumination measurements taken approximately one year after completion of the installation were as follows:

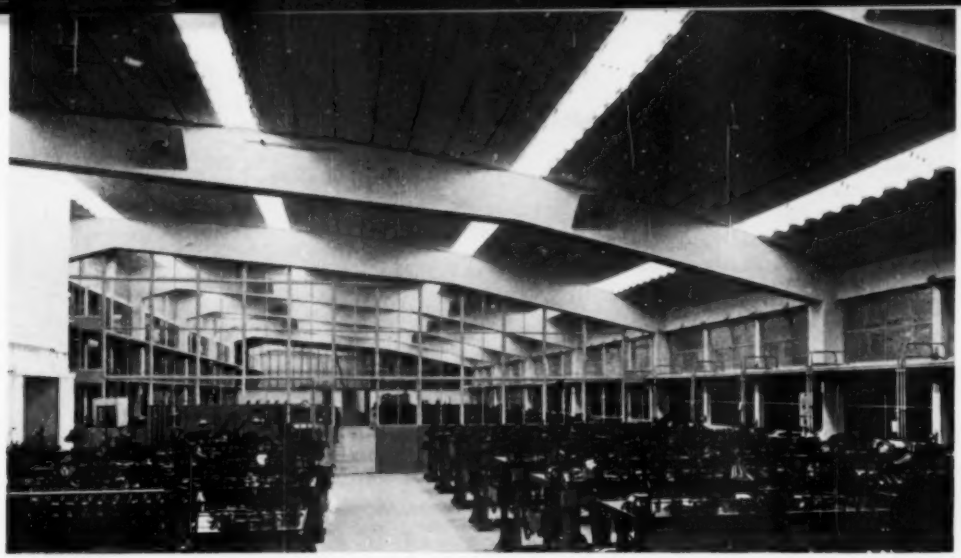
General illumination at counter top height	50	footcandles
Total illumination on counter top	100	"
Vertical illumination on wall case displays 5 feet above floor	50	"
In counter cases	100	"

Brightness readings were as follows:

Ceiling near wall	30	footlamberts
Ceiling at center	12	"
Upper walls	28	"
Lower walls	10	"
Merchandise in wall cases	6 to 12	"
Patterned Terrazzo floor	12 to 25	"
Troffer at 45°	350	"
Troffer at 0°	370	"

Lighting data submitted by Buffalo Niagara Electric Corporation, Buffalo, New York, as an illustration of good lighting practice and to aid in the design of similar installations.

Distributed by the Committee on Publications of the Illuminating Engineering Society, 51 Madison Ave., New York 10, N. Y.



Lighting installation data and photos submitted by L. C. Kalff, Eindhoven, Holland.

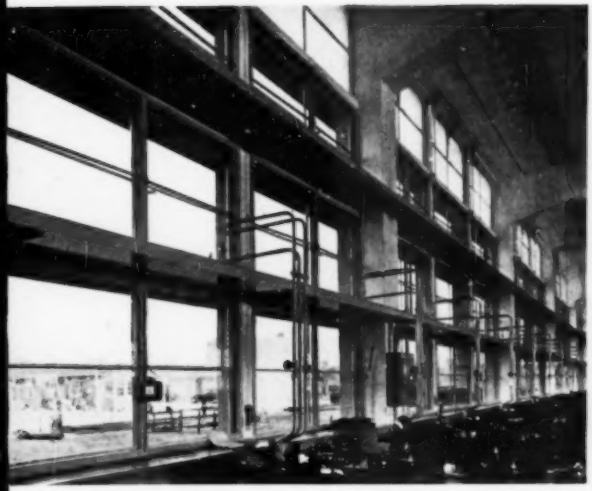
Lighting a Holland Diamond Die Plant

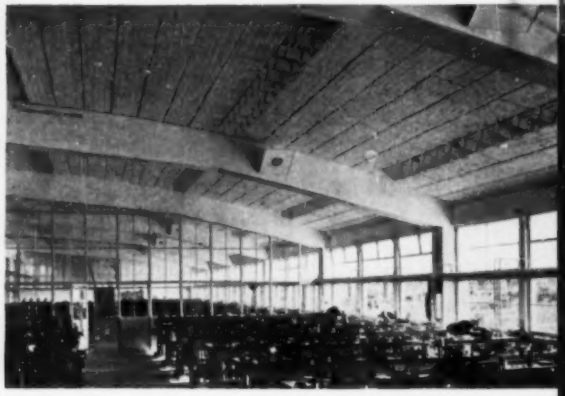
Above. Night view of New Philips diamond die factory, Valkenswaard, Holland. Four rows of three 40-watt fluorescent tubes screened off by miniature louvers.

Left. Outside view. Horizontal concrete slabs make louvers for sunlight between panel. Double-glass top panels of Thermolux glass diffuse light upwards toward ceiling.

Below, left. Details of inner louvers of steel serving at same time to support piping, thus avoiding dust deposits falling on machinery.

Below, right. Interior view, seen from north, 6 p.m. Note uniform brightness of ceiling. During daytime no sunlight can enter. Daylight factor near windows 8 per cent; middle of building, 40 per cent.





DESIGNING PORTABLE LAMPS

(*Continued from page 83*)

served in this manner, especially those bearing on light source size, light source position, shade diameter, depth, lamp height, etc. The futility of diffusing bowls placed high in shades is easily noted since none of the bowl will be visible through many of the holes and only a part of it through others. To obtain real effectiveness, the source of light itself, whether it is a frosted bulb, the side of a white bulb, diffusing bowl reflector or a fluorescent tube, must be visible through every hole in the test card.

After some experimentation, a photographic device was developed so that a complete record could be made at one time of what can be seen through these holes. Being printed, it is permanent and can be measured or examined on the design board. The effectiveness of the pin-hole camera has long been known, although its applicability to commercial photography is not very great. It could, however, be applied to this problem. The device shown in Fig. 6 is comprised of forty-two pin-holes cameras. With it a complete photographic record can be made over the entire test plane at one time through the simple expedient of locating carefully-made pin holes in the centers of small areas that divide the whole surface in equal parts. Squares 2 x 2 inches were used with pin holes 0.01 inch in diameter.

The simple optical principle employed is illustrated in Fig. 7. The black upper surface represents the test plane. Each pin hole in the plane acts as a lens in that it can image behind itself in reduced size an object placed in front of it. For simplicity, an arrow has been used to illustrate an object outside and above the test plane. Behind each pin hole a reduced sized image of the arrow will be formed as indicated. Since there are forty-two pin holes evenly spaced over the 12 x 14 inch test plane, there will be forty-two photographs made at one time of the lamp to be analyzed. Fig. 6 also presents the principal dimensions of the illumination photo-analyzer and

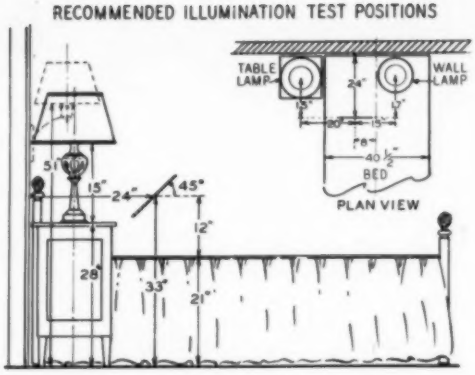
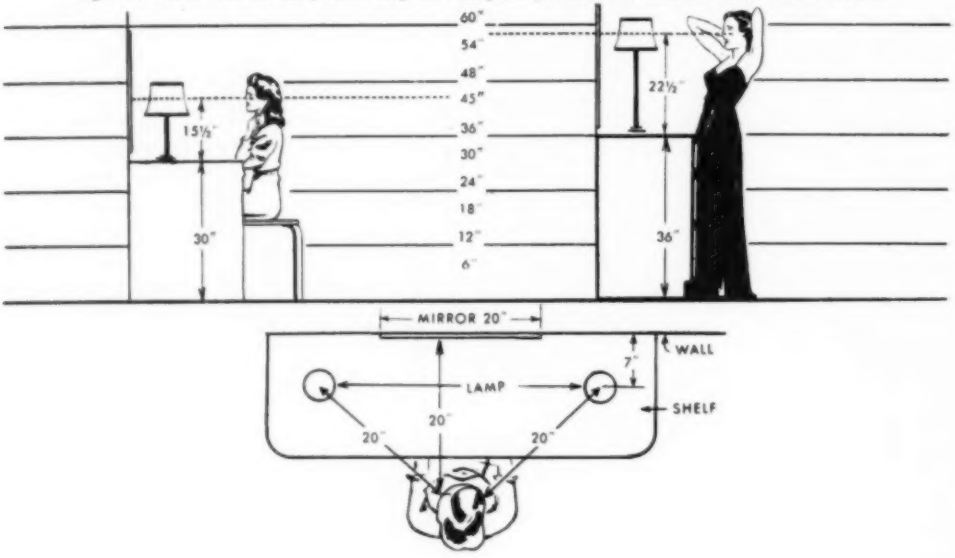


Figure 3. Suggested positions of table or wall lamps and reading test plane for illumination performance tests.

Figure 4. Dresser and dressing table lamp and test plane positions for illumination performance tests.



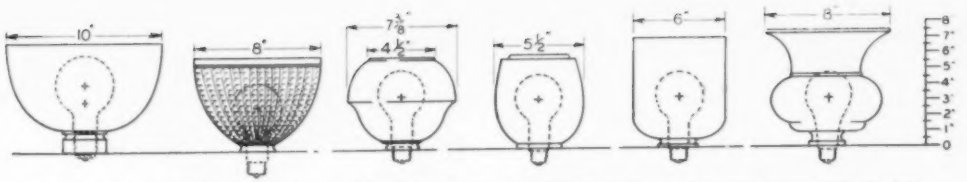


Figure 5. Various diffusing devices used in modern lamps to control upward and downward proportions of light.

the placement of the photo-sensitive material with the back partly removed. The additional four inches on the right-hand side, in which there are no pin holes, is needed when photographing most lamps placed in normal test positioning — off center. This off-centering is typical of usage and may be noted in Figs. 1, 2 and 3. At no time will the individual photos fall directly back of the pin holes since lamps being tested are seldom directly back of or normal to the surface of the test plane.

In Fig. 8, five out of the complete set of forty-two photos are shown. These were obtained from a single negative made when analyzing a C.L.M. floor lamp. These five positions illustrate the four corners and the center of the test plane. The complete set of forty-two are not illustrated since their reduction in size to meet the conditions of this page size would make them too small for good visualization. The full size photo print is 18 x 12 inches. They show how much of the inner diffusing bowl is visible to the test plane at each of the forty-two positions. The illumination values beneath each photo were obtained at each of the respective points and aid in illustrating the final design effectiveness. To eliminate the effect of the upward component of the light from the lamp, some of which is reflected back on the test plane, thereby contributing to greater uniformity, the top and outer shade sides were covered with black cloth. The unevenness in illumination results from the variation in areas of light-giving parts "seen at the test plane" and the distance from source to test plane. Unfortunately, as the distance to the various parts of the test plane increases or decreases, the visible area of the reflector inside the shade increases or decreases, respectively. If this action could be reversed, it would be extremely helpful in gaining greater uniformity of illumination.

The five photographs in Fig. 9 were also obtained from the four corners and the center of the test plane. This illumination photo-analysis shows how the parts of a C.L.M. table lamp work toward providing the result. Practically all table lamps show a greater degree of non-uniformity of illumination than do floor lamps, each well proportioned and well positioned with respect to the user and the areas to be lighted locally. In Fig. 10 the five photos were made with a table lamp having the dimensions so widely used in thousands of homes — 21 inches high with 15-inch shade. The source is a 100-watt inside frosted lamp. Its poor performance in the upper right-hand corner and wide variation in illumination level may be noted from the great differences in the principal light-producing areas shown by comparisons of the four corner photographs. The bottom edge of the shade is too low, the diameter of the shade is not large enough, and the source of light is too high in the shade. Lowering the socket and lamp bulb 2¾ inches makes for better performance — see Fig. 11.

Laboratory Aids

At this point in our survey of the conditions which surround the whole problem of lighting effectiveness design, we should introduce one of the most useful arrangements for designing and testing. Through its use it is possible to assemble quickly such basic parts as sockets and shades to any height and with the light source in any position inside the shade. The parts are available. They are indispensable in laboratories for making working setups for many investigations. The portable lamp manufacturer will find these simple-to-assemble stands and clamps (Fig. 12) great time-savers. With their use, it never becomes necessary to build lamps to pre-test or to check designs. An idea can be given a good overall check in an hour. Furthermore, the possession of these handy parts would undoubtedly do much to encourage experimentation. Even more complex wiring assemblies that will come, for example, with several circular fluorescent lamps, present no preliminary testing problems since everything can be done in the open. As the development of more effective portable lamps progresses, it will be necessary to equip manufacturers' design rooms or shops with just such basic tools of experimentation and testing.

Negative Specular Effects

With the pin-hole test-plane illumination-analyzer, we can determine how much of the real lighting elements of design are working to produce illumination. It may also prove to be of value in analyzing certain types of general and local lighting systems since it always "sees" the complete lighting system right at the point of work. Next we should examine the reflections from the test plane back into the eyes of the user for that will be one way of checking the visual unsatisfactoriness and the unpleasantness of the lamp when viewing the page to be read or written upon. The bad effects back into the eyes from shiny paper, printing ink and especially from many writing pencils, are only reflections of those parts of the lamp that are seen through the pin holes just described. To see them it is not necessary to do the viewing back of the test plane. Instead, they are easily viewed when seated with the eyes in the normal position as stated or indicated in the test positions shown in Figs. 1, 2 and 3. The only piece of equipment needed is a mirror 14 x 12 inches, placed directly upon the test plane. If the light source inside the shade can be seen, its location in the mirror marks the spot or area from which trouble will arise. The seriousness of the trouble then depends upon the "slickness" of the paper used in the newspaper, book or magazine or paper being written upon. It is also dependent upon the "slickness" of the printing ink, writing ink or "lead" left upon the paper when writing. The latter in the softer grades sets up a very annoying condition even when writing upon reasonably dull paper. The effect is particularly annoying at the study table. If all pencils, inks and papers used for reading and writing materials were really dull, this very serious negative effect would not arise and one of the most difficult lighting performance shortcomings would not exist.

At this point we should return briefly to the expedient of increasing the size of the source "as viewed from the test plane" to the greatest possible degree. Now we can appreciate the importance of having light which "arrives" at the mirror coming from as low a brightness area as possible. If it is low enough in brightness when viewed in the mirror, to be at least reasonably comfortable to view, it is not going to be very unpleasant when the mirror is removed and the reflection comes from the same location but from the reading or writing page instead. The average source brightness of lamps made according to the earlier specifications of the Society[6] was approximately 1350 footlamberts. Present C.I.M. lamps,

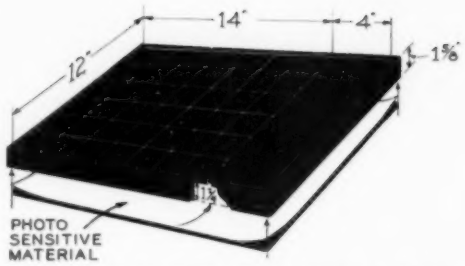


Figure 6. A simple multiple pin-hole photo-analyzer. Back removed showing position of photo-sensitive material.

excepting dresser and dressing table, have source brightnesses averaging 2200 footlamberts. Good placing of lamps, furniture and reading and writing materials will keep much of the image of the source out of the mirror. Under many circumstances of usage, however, we cannot orient the conditions to eliminate the potential trouble. In the investigation of home study conditions it was found to be present and unavoidable in practically every condition tested.[3] We seldom have flat pages in front of us, and once a page has been folded, bent or creased, it will always create trouble unless the paper itself has favorable characteristics and the source brightness inside the shade is low.

Specular Reflections From Magazines

In order that we might have at least an approximate idea of just how difficult a number of large-circulation magazines are to "live with," rather detailed examinations were made of their surface characteristics. Two qualitative appraisals were attempted under a set of lighting conditions closely related to good lamp design practice. The light supplied to each sample came solely from a 6-inch diameter opal glass sphere showing good uniformity of brightness; an average of 2250 footlamberts. When the magazine sample was normal to the center of the source, the illumination was 25 footcandles. All reflected light from the surroundings was excluded from the sample. Under normal conditions of use, there would be light from surroundings in varying proportions and angles; hence, it would be difficult to simulate in-the-home use conditions. It was felt that the fundamental question of source brightness could be studied more effectively by itself at first. In fact, after the basic observations were concluded, light from directions other than that from the sphere was added to one sample to learn the order of magnitude of other illumination needed to eliminate the specular or "shine" effect. These

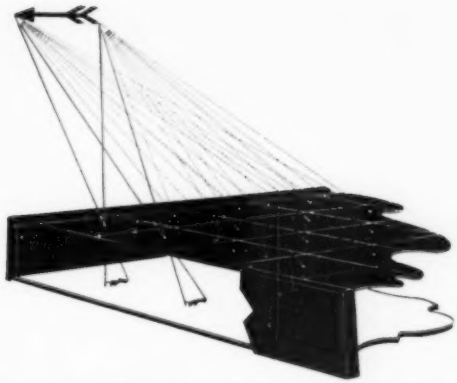


Figure 7. Illustrating how each pin-hole of the photo-analyzer, Figure 6, acts as an independent camera.

observations will be discussed under the effects of indirect or generally distributed light.

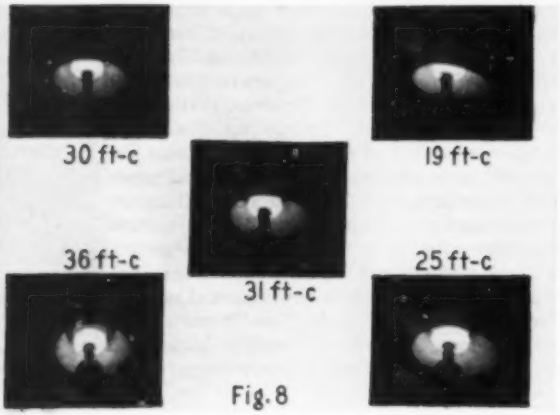
One of the difficult questions to be resolved also came in for some study; namely, does the illumination value on a printed page as it is increased restore lowered visibility produced by unsatisfactory ink, paper and source brightnesses. It too will be discussed later. The results from the direct viewing at normal reading distance are contained in Table II. Samples were selected from each of the magazines and each was carefully mounted so as to obtain the nearest approximation to flatness without using adhesives back of the area to be illuminated and viewed. Each sample was mounted on an optical bench so that the angles of incident light and viewing angles were easily established. The observations were all made at the angles at which the maximum effect of specular or "shine" reflection were visible. The actual angles of maximum reflection were always in good agreement with the simple law of incidence and reflection. This merely served to indicate that the samples were properly mounted and that they had been carefully handled to avoid surface injury or bending.

It may be noted that in general the degree of visual discomfort sensation and reduction of visibility is not increased very much when the angle of the incident light is increased from 30 degrees to 40 degrees. However, marked increases in both effects usually take place when the incident light reaches 50 degrees. Beyond this, serious difficulty arose with every sample examined. The weekly magazine (A-w) with the most satisfactory ink and paper surface is at the top of Table II. Except for the daily newspaper, J_1-d, which rates well on the two criteria used, A-w stands out by itself as being the freest from unpleasant reflected discomfort and reduction of visibility. It does suffer marked reduction of visibility when the angle of incident light becomes as great as 50 degrees. It may be noted, however, that all the other samples suffer still greater loss of visibility at this reasonably high angle of light incidence. In view of the tremendous volume of ink and paper used in the large-circulation magazines, it is surprising that one publisher should show marked excellence relative to the others. A comparison of A-w and D_1-w and D_2-w, both weeklies, indicates the wide spread between this set of samples. Periodicals such as B, C, D, E and H use at least several paper and ink combinations. Samples 1 and 2 in each are from different parts of the magazine.

From the author's own personal experience, the magazine (D_1-w, D_2-w) has long been a visually disagreeable experience. Even with the low-brightness source used in the best quality floor and table lamps, its surfaces are distinctly undesirable and unpleasant. These observations were made objectively and abstractly. Reading as such is not required to make the appraisals. Nonetheless, the negative optical characteristics of this periodical (D_1-w, D_2-w) which stand out clearly under closely controlled conditions of lighting and observation are also easily detected under ordinary conditions in the home when reading

Sample *K* taken from a national engineering society's publication was included since it appeared to be troublesome. It closely resembles G-m, the most difficult magazine of the group. If we are to design our portable lamps with sources low enough in brightness to bring magazines as difficult as these into line, some revolutionary changes in the sizes of the diffusers and lamps are going to have to be made. A change in the paper and ink used in the offending magazines is a more economic solution.

Much more could be said, especially as it applies to the writing materials used by all students, both school and college. Pads, tablets, notepaper and pencils provide a wide range of annoying and visibility-reducing characteristics. Perhaps our lead pencils are at the top of the list of offenders. They meet the light source at the page in front of the student, and since there is no identifiable standard of "sheen" from these materials, we try to design portables, especially those for study purposes, that will free the student from constant visual annoyances. If there is no control of the writing materials used, our portable lamps cannot be realistically designed. We can, of course, over-design in size, and by means



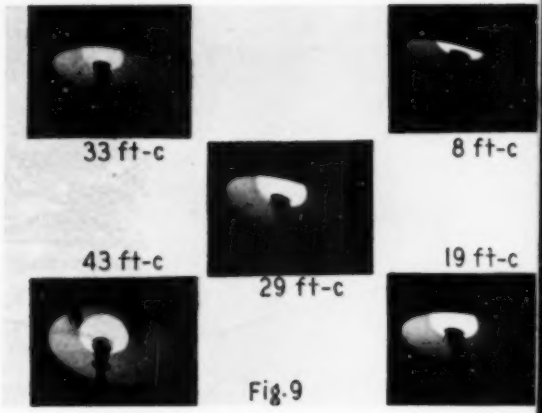
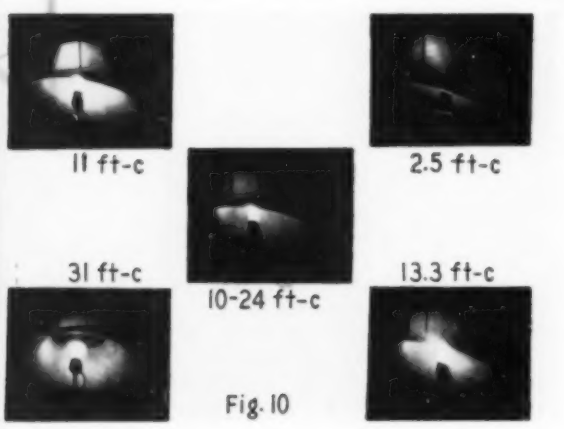


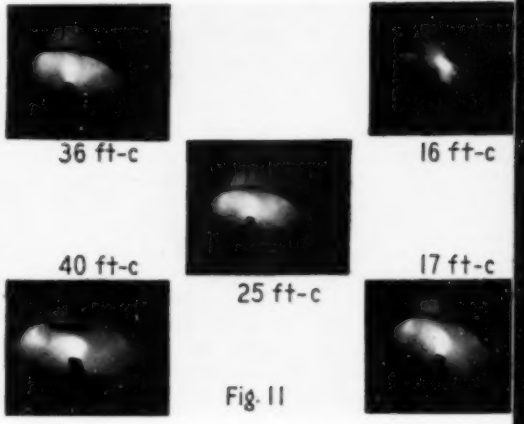
Figure 8. Views of a large C.L.M. floor lamp, 100/300 watt, taken at the four corners and the center of the reading test plane. Illumination values at each are from direct light only. In addition, the indirect light component is 10 footcandles. Lamp placed at left.

Figure 9. Views of a 25-inch C.L.M. table lamp taken at same positions as in Fig. 8. In addition to direct lighting illumination at each point, an indirect lighting value of 3.5 footcandles may be added. Lamp placed at left.

Figure 10. Views of a 21-inch table portable with bare 100-watt filament lamp taken at same test positions as in Fig. 8. In addition to the direct lighting illumination at each point, an indirect value of 1.9 footcandles. The low shade at upper right and the shade cutting through filament at lower right create marked shadow diagonally from top left through center to bottom right of test plane.

Figure 11. Same as Fig. 10 except socket has been lowered 2.75 inches from conventional position. Note addition of light source at upper right corner and its effect on improving illumination values. Shadow mark across test plane eliminated. Add 1.2 footcandles for indirect lighting. Lamp placed at left.





of high amounts of generally distributed light soften conditions, but again that is uneconomic. Surveys of all of these materials are in order, aimed to gradually bring a rational answer to the situation. Such a procedure can benefit great numbers of people. Writing and reading materials that are widely used should be graded and marked for their contribution toward eye comfort. Then the user may select those with good ratings and portable lamp design can be adjusted to supply at least a reasonably economic answer to the overall problem. Portable lamp design aimed to supply current recommended levels of illumination, with lighting results reasonably free from the waste incurred by unpredictable specular effects, cannot meet the problem alone except through the expedient of employing indirect lighting. The cost of doing so was indicated earlier. Several examples of the light required to produce

Figure 12. Laboratory stands and clamps provide the means for arranging lamp parts in any manner needed for testing.

TABLE III

Wattage Required to Provide 25 Footcandles (Incandescent filament lamps)

	Indirect Table Lamp	C.L.M. Table Lamp	Semi-Indirect Floor Torchere
Reading seated in comfortable chair (Fig. 1 test)	420	125[3]	420[3]
Reading seated at study desk (Fig. 2 test)	420	90[2]	675[4]

[1]Opaque shade.
[2]Translucent shade.
[3]Floor lamp test position.
[4]Special position 5 feet to left and 3 feet back of test plane center.

25 footcandles at a study desk and when reading in a comfortable chair are given in Table III.

The values given in this table have been computed from actual measurements. The absolute values are only intended to supply the general order of magnitudes and from these the relative values. These examples indicate that under the most favorable conditions it would require 3 to 4.5 times as much electrical energy to obtain the results with indirect lighting. In these two applications of C.L.M. lamps, approximately four of the 25 footcandles measured over the test plane are indirect. The values obtained from the indirect reflector alone—its efficiency is 80 per cent—indicate that each indirect footcandle on the test plane requires about 17 watts when properly placed table lamps are used. On this basis approximately 65 watts in each of the C.L.M. lamps are used to supply the total indirect component of illumination. All computations used in developing this table employ incandescent filament lamps operating at one efficiency. In this way the complications of adjusting the values for the different efficiencies of lamps, large and small, and of single and two-filament design are eliminated.

The results for a medium density ivory glass semi-indirect torchere having an average brightness of 350 footlamberts is included. If the soft tone ivory glass is replaced with a heavy density white reflector, the wattage for reading in the comfortable chair or at the desk would be reduced by 20 and 30 per cent, respectively. Aside from the point of wattage requirements, other disadvantages associated with the attainment of the desired levels of illumination with indirect lighting alone have already been mentioned.

Since we may not readily employ substantial amounts of indirect lighting in attaining the objective illumination levels, and we do have a wide variety of specular situations everywhere, a further understanding of the latter can aid us in both the design and application of portable lamps. Further interpretations of Table II are helpful. These magazine samples were illuminated at the

several angles indicated and viewed to receive the full impact of the specular effects. Are these angles, namely 30, 40 and 50 degrees of incidence and reflection, possible or commonplace when using lamps in the home? Figs. 13 and 14 illustrate some of the conditions associated with the placing of lamps on desks. Fig. 13 shows the prevalence of such angles of incident light. It also shows the real difficulties associated with the practice of placing desk lamps immediately in front of the user. Just about any practical location on the left-hand side of the diagram, in which a source of light can be placed, will be reflected into the eye from some place on the work surface, from *A* to *B*. If we are going to obtain anything resembling uniformity of illumination on *AB* from lamps placed straight ahead, they may not be removed much more than 17 inches from the front of the desk and the source must be raised as high as is practicable. At the same time, the highest position for the bottom of the shade that is shielding the source from the eye is about 15 inches. Immediately above this shield line, then, we may consider the placing of the source. The row of circles above the shield line *CD* is introduced to show possible positions of light sources that will provide good uniformity of illumination on *AB*. Images of these sources will, however, always interfere wtih vision some place from *A* out on the work plane. The futility of hoping to avoid specular reflection when lamps are placed in front of the user may be completely verified by spotting sources on the diagram at any point above the 50-degree incident light line until the region above and quite close to the eye is reached.

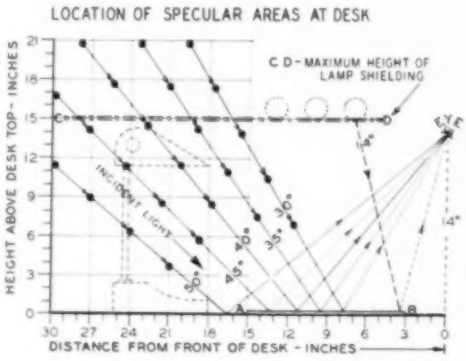
Fig. 14 illustrates the various positions the specular effect occupies as the lamp is moved from straight ahead to positions around to the left. This time we are looking down on the test plane with the eye in the same position as in Fig. 13; that is, 14 inches above the front edge of the desk. The recommended lamp position, 12 inches away from the front of the desk and 15 inches over from the center of the test plane, places the specular area close to the lower left-hand corner of the test plane. Two positions of light source height (15 inches and 19 inches) are included so that the effect of lowering the light source could be illustrated. Moving the eyes to the right moves the specular area centers to the right and vice versa. Lowering the head moves the specular area centers upward. The recommended lamp position goes far toward minimizing the specular area effect by locating it offside down low. Obviously, lamps may also be placed in the same symmetrical position for the left-handed writer by placing the lamp to the right of the figure.

For simplicity, the expressions "point of specular" and "center of specular area" have been used as though the source were always a point or a small circular area. When the source is a diffusely lighted sphere, bowl or of similiar shape, the area of specularly reflected light is spread over a part of the page just as its image in a mirror would be. When it is a straight tube, the specular area becomes a band. The exact location is always in accordance with the principles illustrated in Figs. 13 and 14.

It should be noted that angles of incidence of 30, 40 and 50 degrees are commonly encountered at desks. When seated in living room chairs and davenports, the standard positioning of C.I.E.M. floor lamps places the specular areas well to one side of the test plane and with flat surfaced paper the incident light angles causing specular are not very great, approximately 15 degrees. C.I.E.M. table lamps placed according to standard testing introduce angles of incident light which cause specular troubles at about 30 degrees. In any appraisal of these conditions it should be remembered that other angles of incident light from the source can always plague the reader since the pages are never flat and the roll of the paper in the center of magazines and books always emphasizes the trouble. Even the left-hand page, when reading the adjacent right-hand page, may reflect a large area of annoying brightness into the side of the eye.

A description of the surface characteristics of the paper and printed letters of magazine G-m is included as it presents one of the most unsatisfactory paper and ink surfaces. Upon examination through a microscope, many of the factors which

Figure 13. This cross-section diagram of a desk top and the space above it illustrate the difficulty of designing desk lamps to be placed in front of the user. Typical desk lamp and its positioning included—its illumination ratio from B to A unsatisfactory, nearly 4 to 1.



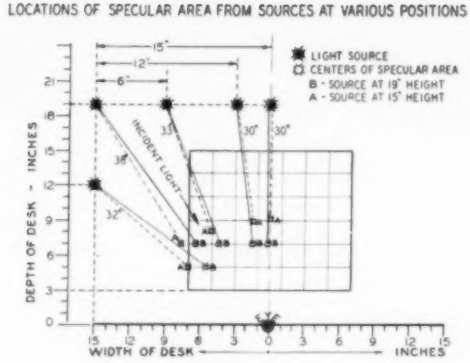
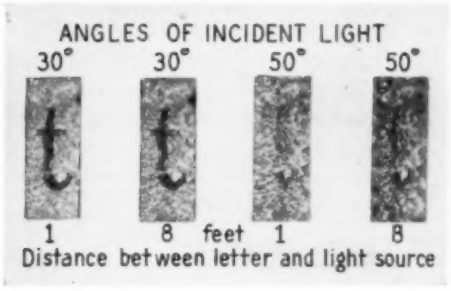

LOCATIONS OF SPECULAR AREA FROM SOURCES AT VARIOUS POSITIONS
LIGHT SOURCE
CENTERS OF SPECULAR AREA
B - SOURCE AT 19" HEIGHT
A - SOURCE AT 15" HEIGHT
INCIDENT LIGHT
DEPTH OF DESK - INCHES
WIDTH OF DESK
INCHES

Figure 14. Looking down on the desk and test plane supplements Fig. 13 in showing how the reflected images may be thrown off side or up and down by various lamp positions.

make for a good or bad combination of paper and ink may be noted. Magazine G-m, the most difficult of the large-circulation magazines included, is illustrated in Fig. 15 considerably enlarged. In fact, not more than the single letter "t" could be viewed clearly through the microscope in all the positions of examination so the illustration only presents this one letter as seen in four positions: near the source and removed substantially from the source with the incident illumination at 30 and 50 degrees for each of these positions. In each, the spherical diffuse source was used for the lighting.

The paper surface itself, viewed when the incident light is at 30 degrees, appears as a series of fine pores. These are not very distinguishable under highly diffuse illumination from the surroundings. When, however, the six-inch diffusing sphere illuminates the sample, the minute spaces between the pores or the sides of each pore reflect light as though they were very tiny mirrors. They are not all arranged exactly in planes to produce the effect of a solid complete mirror, and a considerable portion of the unprinted white paper surface appears dark gray. This grayness is a relative condition since the incident illumination is approximately 125 footcandles. The adjacent highly irregular highlights induce this grayness through contrast. The ink producing the letter "t" lies over the highlight and pore areas but does not fill them completely, so we still have some of the surface pore construction showing through the printed letter. The deposit of ink forming the letter "t" appears as round black dots very unevenly deposited with gray areas filling in the "t" under surrounding diffuse lighting. The letter itself is firmly outlined by a fine black line. When the 30-degree incident light strikes the letter, and the diffuse surround lighting is removed, the round dots of ink become tiny scintillating jewels of light. These in turn appear to be on top of a layer of gray ink.

Figure 15. A single letter "t" from magazine, G-m Table II, magnified ten times—light-source brightness constant. When viewed without magnification, the reduction of visibility of the two left-hand "t's" is marked. No trace of the letter may be found under the right-hand conditions.



The spherical source of light is near at hand so a high brightness effect prevails over both the paper and ink. The incident illumination is about 125 footcandles. The contrast between the "t" and the background is not very great. Will the "t" disappear as we move the source of light away from the printed letter? We would expect it to do so if the specular reflectance of the ink is higher than the specular reflectance of the paper. We do not know these individual specular reflectance values of the ink-on-paper and paper. They are difficult to measure when only the very small elements of a letter may be measured. Furthermore, the values differ greatly at various angles of light incidence. We can, however, witness the disappearance of the letter if the surface of the ink and paper combine to produce this effect under certain lighting conditions. Some black and even colored inks may be found with such high specular reflectance values that they become brighter than the paper upon which they are printed. The magazine samples in Table II were examined also to learn whether inks with such marked specular reflectances were in common use.

In principle at least, we would expect the letter "t" to disappear or become very faint if we reduced the illumination by moving the light source and the printed sample apart. First it was rather surprising to find that the letter could be seen when the light-source-brightness-footlambert value was 1800 times the footcandle value of the

incident illumination—the light-source brightness was increased to 22,500 footlamberts. This was when the source and sample were substantially separated from each other. As they were moved apart, the gray values in both the pores of the paper and ink became darker and the number of points that scintillated became fewer in number on both paper and ink. The brightness of the very tiny mirror-like areas was not, however, altered very much, and there was a reasonable but low margin of visibility left even when the incident illumination had been decreased to one-tenth the original value, *i.e.*, from 125 to 12.5 footcandles.

Next, the sample was brought back to the high illumination position close to the source and turned to a 50-degree incident position. At this point the letter "t" practically disappears, only the slightest trace of its location being detected. Moving the sample to the position at which the illumination decreases to one-tenth, there is no change in the visibility and there is no reversal of the brightness in "t"; *i.e.*, it does not become brighter than its surroundings. From this we may assume that the specular reflectance of the ink is not greater than the specular reflectance of the paper at 50 degrees of incident light.

At this point it should be noted that this detailed examination and reporting applies to magazine G-m, one of the most unsatisfactory. All of the magazines were examined in the same manner. In no instance was the ink sufficiently specular to cause the printed letter to reverse and become brighter than the page, and in no instance did there appear to be any marked improvement in the visibility when the illumination was increased ten-fold. Whether the reduction in visibility introduced by specular under the conditions of these observations can be offset by increased illumination by a given source at a given value of brightness under levels of illumination that may be practically attained is open to question and further investigation. The effect seems to be more closely related to the absolute brightness of the source producing the undesired effects than to other conditions.

The negative effects of specular may be lessened by illuminating the surface at the same time with light from any direction except the direction that is already causing the effect. Generally distributed light from the walls and ceiling around the individual is therefore very helpful. The higher the light source brightness, the greater the amount of generally distributed light needed. It also appears as though the shorter the distance between the source and the specular surface, the greater is the need for generally distributed light.

From every angle of approach the attainment of visual comfort and high visibility from printed and written pages is only assured when the light source is large and of low brightness and when there is generally distributed light also on the page. From observations made, even the invisible "t" (see two right-hand illustrations in Fig. 15) can be restored to normal black and white contrast through the addition of 25 times the illumination already present. The source producing the specular was at 22,500 footlamberts. The low contrast situation represented in the left-hand side of Fig. 15 was restored to full black and white contrast through the addition of from 3 to 6 times the original illumination associated with the specular effect. It should be remembered that this additional light must come from directions other than that existing between the original source of light and the reading or writing surface. Further studies will provide the necessary data for a wide range of inks, papers, light source brightness and the associated illumination values. Such data may afford the best basis for the selection of future design values for light source brightness. The other basic reason for generally distributed light, the attainment of overall visual comfort when using the lamp, remains to be discussed.

Direct Viewing Visual Comfort

Both the Committee on Residence Lighting of the Illuminating Engineering Society and the Technical Comittee of the Certified Lamp Makers have recognized the need for establishing a number of positions at which a lamp to be appraised is viewed. The lengthy and complex methods of making such appraisals have led the author to attempt shorter and simpler methods.

EDITOR'S NOTE: This subject will be developed further in the concluding part of Mr. Commery's paper appearing in the March issue of ILLUMINATING ENGINEERING. He will discuss direct viewing visual comfort, various design combinations and visual comfort from surroundings, together with extensive supporting test results.

TELECAST

LIGHTING NEWS OF CURRENT INTEREST

Review of Executive Committee Meeting, New York

The bi-monthly meeting of the Council Executive Committee of I.E.S. was held January 12 in New York City. Present were: C. H. Goddard, Vice-President; A. H. Mauwaring, General Secretary; E. M. Strong, Treasurer; A. D. Hinckley, Executive Secretary; and Paul H. Hildebrand.

MEMBERSHIP

A report of the Board of Examiners, submitted by R. C. Kinney, Chairman, presented for election 6 Members and 15 transfers from Associate to Member; 93 Associate Members, and 9 Student Members. Favorable action by the Committee on the Report, together with other changes in the membership, result in the following tabulation of membership figures:

September 30, 1948		January 12, 1949
6,516	Total membership	6,711
21	Members Emeritus	24*
45	Fellows	43
1,406	Members	1,459
4,908	Associate Members	5,007
136	Student Members	178

*Includes 5 Fellows of the Society.

NEW COMMITTEES

In addition to the several appointments to existing committees (up-to-date personnel of which is published in this issue), the Executive Committee took action on a number of new committees first proposed by the Project Planning Committee in its December 8 report to Council. One is an entirely new project to the Society—a proposed Task Committee on the Society's historical background. It was the thought that such a committee could start now to prepare for the Society's 50th Anniversary in 1956. Action was taken by the Executive Committee confirming the appointment of such a Task Committee, name and scope of which will be determined later. Personnel appointed included S. G. Hibben, Chairman, W. C. Brown, Preston S. Millar.

A proposed Advisory Committee on Committee Personnel, previously suggested by the Project Planning Committee, was also discussed. Appointment of this committee was confirmed, with the recommendation that it be referred to the Committee on Constitution and By-Laws for consideration as a Standing Committee of the Society. Such a committee would meet on call of the President-Elect any time after the elections in May for the purpose of reviewing and making recommendations regarding committee personnel for the year. Personnel of this committee would be made up of the Senior and Junior Past-Presidents, Senior Vice-President, Executive Secretary and the Technical Director of the Society.

A technical committee on Lighting of Central Station Properties, previously approved for letter ballot, was further discussed at this meeting, especially in regard to a statement of scope and in regard to a number of suggestions submitted by the Project Planning Committee. Scope for the proposed committee was approved to be "To study and report on the lighting of electric power generating plants and their distribution facilities."

LOCAL ACTIVITIES REPORT

Walter Sturrock, Chairman of the Committee on Local Actitvities, reported considerable activity among the Sections and Chapters, including extension work in Tennessee and in the Maritime Provinces of Canada, which may result in the establishment of new Chapters.

Paul H. Hildebrand, of the Eastern Pennsylvania Chapter, who was present at the meeting, presented for the Committee's official approval a proposed Regional competition on "My Most Interesting Job." The project, details of which are described elsewhere in the Telecast, was approved with the provision that its financial support be from local sources, that entries be on the basis of good lighting practice, and that judges of such competition be members of I.E.S.

Mr. Sturrock further presented a communication from Harry Grattan, Jr., Regional Vice-President of the East Central Region, reporting on the Capital Section's proposed commercial lighting design course for electrical contractors. The course is proposed to be jointly sponsored by I.E.S. and the Electric Institute of Washington. Action was taken to approve this project with the understanding that the judgment of the proposed design problem on store lighting be made by members of the Society and that the presentation of prize copies of the I.E.S. Lighting Handbook be financed locally.

CONNECTICUT CHAPTER NOW A SECTION

Two communications were presented to the Executive Committee from the officers of the Connecticut Chapter and G. W. Beals, Regional Vice-President, in connection with application of that Chapter for transfer to Section status. Favorable action approved this transfer, making the Connecticut group a new Section.

PROFESSIONAL STATUS IN GEORGIA

Georgia Section also presented a special activity for approval, reported by Mr. Sturrock through a communication from J. B. Browder, Southern Regional Vice-President. Mr. Browder reported that the Georgia Section is taking steps to assure that the State Examining Board designates illuminating engineering as a recognized profession in that state. In a general discussion of this and similar activities the relation of such matters to the studies now under way by the Professional Prerequisites Committee was pointed out. It was agreed also that the attention of the Sections and Chapters should be called to the April 1946 report of the Committee on State Licensing of Professional Engineers.

NEW REPORTS APPROVED

The General Secretary reported a majority vote in a letter ballot approving the acceptance for publication of

two technical committee reports. Approved reports were:
Lighting for Woolen and Worsted Textile Mills—1948, Part I.
Recommended Practice of Lamps for Aviation, November 1948.

E.E.I. Sales Training Film on Home Lighting

"Lighting the Home the Sunshine Way" is the title of a new sales training film on home lighting recently prepared by the Edison Electric Institute for use in training home lighting personnel of electric companies, department stores, contractors and retailers.

Prepared as a supplement to the Institute's Sales Training Program, consisting of 18 sound-slide films and supporting material, the film applies basic sales techniques taught in this well-known course to the selling of residential lamps and fixtures, and was produced in answer to many requests from utilities, electrical leagues and others for instructional material for use in the home lighting field.

The film features a case history of the re-lighting of a living room, which illustrates many lighting faults often found in the average American home. Betty Smith, a lighting representative, analyzes the illumination and points out to the homemaker the glare from improperly shaded lamps, harsh shadows, bulbs inadequate for the seeing tasks performed, and other flaws.

Discussing each in turn, she appeals to basic buying motives, as she learned to do in the EEI course—to "pride and prestige," by showing how better light will improve the room's appearance; to "comfort and convenience," by illustrating how poor light hampers the family's enjoyment of their home, and to "health and safety," by telling how eyestrain and its accompanying ills may often be caused by poor light.

Step by step, the lighting representative establishes the family's need for modern lighting. She then leads the housewife through the sales process as taught in the Basic Sales Training films, and works out the changes and new lighting equipment needed to assure good light.

The film then reveals the living room after it has become a real "Sunshine Room," with the recommended correction for each original lighting fault shown in full. Other rooms in the average home are also shown, and their lighting needs described.

Four basic principles of good lighting are emphasized for utility and dealer sales personnel to follow. These are listed as: 1. Provide enough light for each task. 2. Eliminate glare. 3. Avoid harsh shadows. 4. Assure balanced light over the entire room.

A complete set of supporting materials are made available with each sound-slide film. A salesman's manual, which covers in more detail the ideas presented in the film, can be distributed to students for permanent reference. A silent trailer film, which the person conducting the sales training meeting can use to stimulate discussion and emphasize the more important points, and a leader's guide, with practical suggestions for the instructor, complete each set.

"Lighting the Home the Sunshine Way" is available from Edison Electric Institute, 420 Lexington Ave., New York 17, N. Y., at $30 per set, which price includes the film and record, leader's guide and silent film. The salesman's manual is offered at 75c per copy.

Lighting Courses Underway

An advanced course in "Lighting Design Problems" started February 7th at New York University conducted by the university with the cooperation of the New York Section of I.E.S. Outline of the course, which is based on the I.E.S. courses, was planned by the New York Section's Education Committee under the direction of E. H. Salter, Chairman, and the faculty is made up of leading I.E.S. members in that section.

The course is being conducted as a regular part of the curriculum of the New York University Division of General Education. Outline of the course includes:

Feb. 7—Illumination Design Methods, L. T. Johnson, lecturer.

Feb. 14—Brightness Ratio Calculations (Using Q and Q Report No. 4) by B. F. Greene.

Feb. 21—Color in Illumination, G. B. Buck, Jr.

Feb. 28—Fixture Design Evaluation, E. H. Salter.

Mar. 7—The Problem of Heat in and from Lighting Equipment, E. H. Salter.

Mar. 14—Daylighting, B. F. Greene.

Mar. 21—Office Lighting Design Problems (Using I.E.S. Lighting Data Sheets), L. T. Johnson.

Mar. 28—Store and Display Lighting Design Problems (Using Data Sheets), F. Wolff.

April 4—School Lighting Design Problems (Using Data Sheets), C. L. Crouch.

April 11—Industrial Lighting Design Problems (Using Data Sheets), J. C. Forbes.

April 18—Floodlighting Design Problems, J. S. Haney.

April 25—Evaluating the Lighting Installation, E. H. Salter.

May 2—Wiring and Installation of Lighting Systems, Alex Sitkin.

May 9—Economics of Lighting Systems, George J. Taylor.

May 16—Infrared and Bactericidal Radiant Energy, J. D. Hall and C. W. Flood, Jr.

The Residence Lighting Forum of the New York Section is also repeating this year, its successful course on Practical Methods of Lighting Residential Interiors. This is a course designed primarily for interior decorators and architects, and last year educated 70 decorators in the New York area in the application of lighting in the home. A similar five-week course is being offered throughout the month of March. Outline of the course is based on returns from a questionnaire to last year's students, indicating what lighting information they felt would be most helpful to decorators. Conducted entirely under the auspices of the New York Section Residence Lighting Forum, the course is under the direction of Lillian Eddy, Chairman of the Educational Committee.

The five sessions of the New York Residence Lighting Forum course will be according to tentative plans:

Mar. 1—The Tools of Lighting, Lillian Eddy, General Electric Co., New York, N. Y.

Mar. 8—How Lighting Affects Moods and Interior Colors, E. W. Commery, Lamp Dept., General Electric Co., Nela Park, Cleveland, Ohio.

Mar. 15—Harmonizing Lighting and Decoration, Mary Webber, Lamp Dept., General Electric Co., Nela Park, Cleveland, Ohio.

Mar. 22—How to Design and Plan for Built-in Lighting Installations, Myrtle Fahsbender, Westinghouse Electric Corp., Bloomfield, N. J.

Mar. 29—Solutions to Specific Lighting Problems, Donald P. Caverly, Sylvania Electric Products, Inc., New York, N. Y. and Francis P. D'Esopo, The Wiremold Co., Hartford, Conn.

Two courses are currently under way in Chicago, with a third course, on Lighting Design Problems, to be offered in the spring. Lecture and laboratory courses on Lighting Fundamentals and Specialized Lighting Discussion are being held through March at the Chicago Lighting Insti-

tute. Robert Ligare is lecturer for the 12-week Fundamentals Course. For the Specialized Lighting Discussion Course, a different lecturer, a leading engineer in the subject covered, is featured at each of the thirteen sessions. The courses are sponsored jointly by the Chicago Lighting Institute, the Chicago Section of I.E.S., and the Illinois Institute of Technology.

The Toronto Section, as in New York, is conducting its lighting course at a university. Their course in "Lighting Design and Applications" is currently being conducted, through March 10, at the University of Toronto as an extension course. It is sponsored entirely by the Toronto Section of I.E.S., with the cooperation of the university. The course outline includes:

Jan. 6—Review of Fundamentals and Planning—Types of lighting; design calculations; general layouts, by F. G. Reed.

Jan. 13—Brightness Values and Glare—Brightness in nature; desirable brightness ratios of interiors; control of direct and reflected glare, by F. G. Reed.

Jan. 20—Fixture Design Evaluation—Performance of luminaires; evaluation and selection; design development, by M. K. Strang.

Jan. 27—Colour in Illumination—Colour characteristics of illuminants; application of colour in lighting and decoration, by Grant Davidson.

Feb. 3—Problems in Office Lighting—Solution of both simple and the more difficult office-lighting problems, by M. K. Strang.

Feb. 10—Problems in School Lighting—General lighting, chalkboard lighting; sight-saving classrooms, other rooms, by J. M. Chorlton.

Feb. 17—Problems in Store Lighting—General display, and atmospheric lighting, colour, by D. S. Martin.

Feb. 24—Problems in Factory Lighting—Steel, textile, paper, leather, printing, etc., A. G. V. Smith.

Mar. 3—Problems in Floodlighting—Sport field, advertising, protective, etc.

Mar. 10—Field Survey Methods—Evaluation of lighting installations, survey-forms, F. G. Reed.

Committee Meetings at French Lick

R. F. Hartenstein, Chairman of the National Technical Conference Committee, announces that arrangements have been made at the French Lick Hotel to provide meeting room facilities for committees of the Society to meet Sunday, September 18, and Monday morning, September 19. It is expected that this will help elminate any conflict with the Conference Technical Sessions. Committee Chairmen planning meetings at French Lick *should notify the Executive Secretary, A. D. Hinckley, at headquarters, by* June 1, 1949, if possible.

Better Sight Bureau Has Lighting Program for Grade Schools

An educational program, for use in the fifth and sixth grade classes of elementary schools, which will assist teachers to bring their students important information on the relationship between light and sight, with helpful instruction on the use of modern lamps and fixtures for more adequate sight protection, has been prepared by the Better Light Better Sight Bureau.

Materials which the teacher can use to conduct a series of three lessons is provided, with emphasis on the functions of the eye in seeing, the importance of adequate light for varied seeing tasks, and the proper use of light to help the eyes.

The educational aids feature a series of twelve large-size charts, in color, which illustrate such points as the partnership between light and sight, need for proper eye care, danger to the eyes created by glare and the hard work that eyes must do under modern living and working conditions.

A series of three leaflets, amplifying the subject material of the charts, is provided for distribution to students. Carefully written to hold interest and to be readily understood by the children, each leaflet describes a major aspect of seeing work done by the child in normal study, work and play activities.

Three quiz sheets, designed to discover how well individual pupils have grasped the instruction, are another important part of the program. Use of these tests will indicate to the teacher whether any part of the work should be reviewed or approached from another direction, in order to assure complete understanding.

An eight-page teacher's guide book provides specific assistance in the use of the study leaflets, charts and quiz sheets. In addition, the guide book describes several class activities, such as simple scientific experiments, compositions and scrapbook work, which will help to dramatize each part of the story of light and sight.

To introduce this program, the Bureau has prepared two plan books, one designed for presentation to school administrators, which outlines reasons for this program, the type of educational aids provided and its value to students. The second plan book is intended to guide electric company representatives in making the program available to schools in their areas.

The program was prepared by the Bureau's Home Lighting Education Committee, in consultation with the Research Division, National Education Association, Washington, D. C.

"The need for this program, and the type of material to be included, were indicated by the results of a survey of 150 school administrators and teachers in 26 states, 98 per cent of whom expressed approval of such a program. The information contained in the charts, leaflets and other aids was initiated at a two-day meeting of school teachers, administrators and officials of the Research Division, National Education Association, followed by two years of research and study by members of the Bureau," it was said by Ralph P. Wagner, Chairman of the Better Light Better Sight Bureau. "The program itself was designed as the answer to thousands of requests from school personnel for educational material on the principles of light and sight, and to bring to their pupils the latest sight-saving information from our lighting laboratories, which can best be made available by the local electric company's sponsorship of this program."

Complete sets of these materials, for classes of 40 pupils, are offered by the Bureau, at $6.50 per set. Plan books and materials are available from the Better Light Better Sight Bureau, 420 Lexington Avenue, New York 17, N. Y.

A.S.A. Proposes Standard for Gray Finishes, Industrial Equipment

Four shades of gray for use in painting industrial machinery and equipment are recommended in a proposed standard for Gray Finishes for Industrial Apparatus and Equipment now being circulated by the American Standards Association for comment and trial use. Although the standard does not recommend that gray necessarily be used, it does suggest that when industrial apparatus is painted gray the use of these standard shades will help in matching the shade desired and in providing better color harmony.

The four standard grays are described according to number and Munsell notation since it is expected that for industrial use the exact identication will be desired. For the convenience of individuals, however, color chips have been prepared so

that anyone interested can visualize what the color described will look like on his machines. These color chips can also be used in making a quick visual check or comparison of colors.

The four standard grays recommended are: Light gray; medium light gray (or standard machine tool gray 7-B); medium gray and dark gray.

The proposed standard not only identifies the standard grays by number and Munsell notation and provides for the use of color chips as secondary standards, but also recommends tolerances for both the secondary standards and the spectrophotometric work. In addition it makes recommendations as to gloss and texture.

An appendix describes the use of the Munsell notations and makes recommendations as to how to use the secondary standards.

The Proposed American Standard Gray Finishes for Industrial Apparatus and Equipment, Z55, was prepared by a committee of 16 national organizations, producers and users of industrial equipment and producers of industrial finishes, and four individual members widely recognized as authorities in the use of color. The committee is sponsored by the Mechanical Standards Committee under the procedure of the American Standards Association.

Copies of the Proposed American Standard on Gray Finishes for Industrial Apparatus and Equipment, Z55 can be obtained from the American Standards Association, 70 East 45th St., New York 17, N. Y. Color chips illustrating the proposal are available at $1.00 per set.

Twin City Section Loses Secretary

At its January meeting the Board of Managers of the Twin City Section regretfully accepted the resignation of its Secretary-Treasurer—John W. Peterson, of Graybar Company, St. Paul. Mr. Peterson was transferred January 1st to Milwaukee, where he will be Manager of the Lighting and Lamps Department of the Graybar Co. Twin City Section had been looking forward to Mr. Peterson's leadership as Chairman of their Section in 1949-50, and have extended their congratulations to the Milwaukee Chapter in gaining a valuable member.

Robert Hamilton, of Smitheraft, was unanimously elected by the Board, to serve as Secretary-Treasurer for the remainder of the year.

Mr. A. L. Weidt was elected to the Board of Managers to fill Mr. Hamilton's previous office.

LIGHTING CALENDAR

Society Events

February 9, 1949 — Meeting of I.E.S. Council, 51 Madison Avenue, New York, N. Y.

February 10, 1949 — Meeting of I.E.S. National Nominating Committee, 51 Madison Avenue, New York, N. Y.

March 3-4, 1949 — South Pacific Regional Conference, San Francisco, Calif.

March 9, 1949 — Meeting of I.E.S. Executive Committee, New York, N. Y.

March 10-11, 1949 — Pacific Northwest Regional Conference, Portland, Ore.

April 3-5, 1949 — Southwest Regional Conference, Houston, Texas

April 7, 1949 — Meeting of I.E.S. Council, Edgewater Beach Hotel, Chicago, Ill.

April 28-29, 1949 — Canadian Regional Conference, Toronto, Canada

May 12, 1949 — Meeting of I.E.S. Executive Committee, Hartford, Conn.

May 13-14, 1949 — Northeastern Regional Conference, Hartford, Conn.

May 23-24, 1949 — Great Lakes Regional Conference, Rochester, N. Y.

June 2-3, 1949 — East Central Regional Conference, Harrisburg, Pa.

June 8, 1949 — Meeting of I.E.S. Council, 51 Madison Avenue, New York.

July 13, 1949 — Meeting of I.E.S. Executive Committee, Philadelphia, Pa.

September 19-23, 1949 — National Technical Conference, French Lick Hotel, French Lick, Ind.

Industry Events

Jan. 31 - Feb. 11, 1949 — Western Institute for Traffic Training Course, University of California, Berkeley, Calif.

February 11, 1949 — Annual National Observance of the Birth of Thomas Edison, Milan, Ohio

February 11, 1949 — Edison Pioneers, 32nd Annual Luncheon and 31st Annual Meeting, Hotel Suburban, E. Orange, N. J.

March 7-10, 1949 — Institute of Radio Engineers, National Convention, Hotel Commodore and Grand Central Palace, New York, N. Y.

March 8-11, 1949 — Essex Electrical League, Fifth Electrical Exposition, Mosque Theatre Bldg., Newark, N. J.

March 9, 1949 — Inter-Society Color Council, 17th Annual Meeting, Hotel Pennsylvania, New York, N. Y.

March 10-12, 1949 — Optical Society of America, Annual Meeting, Hotel Pennsylvania, New York, N. Y.

March 13-18, 1949 — National Electrical Manufacturers Ass'n, Winter Convention, Edgewater Beach Hotel, Chicago.

Week of March 28, 1949 — Third International Lighting Exposition and Conference, Hotel Stevens, Chicago, Ill.

March 29 - April 1, 1949 — 19th Annual Safety Convention and Exposition, Hotel Pennsylvania, New York, N. Y.

April 4-6, 1949 — American Gas Association, Distribution, Motor Vehicle, and Corrosion Conference, Netherland Plaza Hotel, Cincinnati, Ohio

April 5-7, 1949 — A.G.A. Sales Conference on Industrial and Commercial Gas, Andrew Jackson Hotel, Nashville, Tenn.

April 11-13, 1949 — A.G.A. E.E.I. Spring Accounting Conference, Hotel Book-Cadillac, Detroit, Mich.

April 12-13, 1949 — Canadian Electrical Distributors Association, Annual Meeting and Conference, General Brock Hotel, Niagara Falls, Ontario, Canada

April 19-21, 1949 — American Institute of Electrical Engineers, South West District Meeting, Baker Hotel, Dallas, Texas

May 1-6, 1949 — National Fire Protection Association, Dinner and Dance, Hotel Astor, New York, N. Y.

May 7, 1949 — Eastern Electrical Wholesalers Association, 41st Annual Convention, Netherland Plaza Hotel, Cincinnati, Ohio

May 16-19, 1949 — National Fire Protection Association, 53rd Annual Meeting, Fairmont Hotel, San Francisco, Calif.

May 30 - June 10, 1949 — Canadian International Trade Fair — Exhibition Grounds, Toronto, Canada

June 20-24, 1949 — American Institute of Electrical Engineers, Summer General Meeting, New Ocean House, Swampscott, Mass.

June 21-23, 1949 — American Society of Heating and Ventilating Engineers, Semi-Annual Meeting, Minneapolis, Minn.

June 28-30, 1949 — Canadian Electrical Association, Annual Convention, Banff Springs Hotel, Alberta, Canada

July 2-9, 1949 — New York State Association of Electrical Contractors & Dealers, Inc., Golden Anniversary Convention, Chicago, Ill.

August 23-26, 1949 — American Institute of Electrical Engineers, Pacific General Meeting, Fairmont Hotel, San Francisco, Calif.

October 17-20, 1949 — American Gas Association, Annual Convention, Chicago, Ill.

October 17-21, 1949 — American Institute of Electrical Engineers, Netherland Plaza Hotel, Cincinnati, Ohio

October 31 - Nov. 4, 1949 — 37th National Safety Congress, Chicago, Ill.

Experimental School Lighting Project in Minneapolis

Sponsored by the Minneapolis Board of Education, and under the direction of the Twin City Section of I.E.S., eight typical Minneapolis classrooms, each in a different building and each with a different orientation, will soon be completely renovated on an experimental basis to determine standards for the best visual environment. Included are the installations of eight different lighting systems, repainting, resurfacing desk tops and floors, and changing chalkboards and daylight controls.

This experimental project follows a report recently presented to the Lighting Committee of the Minneapolis Board of Education by the School Lighting Committee of the Twin City Section, Illuminating Engineering Society. The report covers a year's study of all physical factors affecting the seeing environment with complete tabulated data and recommendations for improvement based on the new American Standard Practice of School Lighting.

Fixtures selected by the committee cover all I.C.I. classifications with a breakdown of the general diffuse category to include one 60% up—40% down distribution; one 50% up—50% down; and two 40% up—60% down luminaires. One room will have slimline fluorescent lamps with a system of baffles hung from the ceiling. All installations will provide a maintained minimum level of thirty footcandles.

The Twin City Section, Illuminating Engineering Society, School Lighting Committee, which presented this report, will be retained for technical advice and assistance and will continue their studies of the new environment for future reports. Raymond V. Nord, Principal of the Minneapolis Vocational School, is Chairman of the Board of Education Committee; and L. B. Paist, Supervisor of the Lighting Department, Northern States Power Company, is Chairman of the Illuminatng Engineering Society group.

The project represents "the dissemination of knowledge," and a Society service on a most constructive plane.

The Pittsburgh Award

The Pittsburgh Section of I.E.S. has underway a most interesting activity in its competition for reports on "My Most Interesting Lighting Job."

Purpose of the competition is to further locally, the Society's objective of disseminating knowledge of the science and art of illuminating engineering, and to stimulate interest in planned lighting in the Pittsburgh area. An additional benefit is the stimulation of good papers on lighting practice for the Section and Regional programs, and the furnishing of material for National Lighting Data Sheets.

Judgment of the competing reports on "Interesting Lighting Jobs" is based on good lighting practice exemplified in the installation. Each entry is judged by a competent board of three judges, all members of the I.E.S. Pittsburgh Section.

Two awards of $25.00 each will be made for the winning reports. In addition, the entrants submitting the six best reports will be invited to present them before local or extension meetings of the Pittsburgh Section, the best report to be recommended for presentation on the Regional Conference program. The reports of all entrants winning cash awards and those selected for presentation on Section or Regional Conference programs will be turned over to the Data Sheet Chairman for submission to National Headquarters. Rules of the contest are few and simple.

The contest is open to all active members, associate members, and sustaining members of the Pittsburgh Section of the Illuminating Engineering Society.

Written reports on "My Most Interesting Lighting Job" must be submitted by April 15, 1949.

Lighting installations described must have been made between January 1, 1948 and April 15, 1949.

The report must contain a simple and convincing statement as to why it is the most interesting lighting job —from a lighting standpoint.

The report must be accompanied by sealed plan layout, photographs, illumination data, and all pertinent supplementary data.

Sections or Chapters conducting such contests must, by constitutional provision, submit details of their activity to I.E.S. Council for final approval.

BOOKS AND PAMPHLETS

Color Planning for School Interiors is the title of a new manual recently released by the St. Paul (Minnesota) Department of Education. Prepared by W. C. Davini, Assistant Superintendent in charge of Business Affairs and edited by M. Pleason, Color Consultant, the book stresses the coordination of light and color for good visual environment in the classroom.

The book is unique in presenting for the first time the correlated views of color consultants, educators, a school administrator and an oculist, based on extensive studies, research and more than a year's practical experience in four experimental classrooms. Sections in the manual include:

Procedure in Planning the Color Scheme —M. Pleason.
Guiding Principles in School Decoration—Clifton Gayne, Jr., Director of Art Education, U. of Minn.
Color and Light (Fundamentals)—M. Pleason.
Color Characteristics—M. Pleason.
The Eye and Its Activity—Dr. Robert Tracht.
Paint Colors and Safety—Wm. C. Davini.
Paint Colors and School Lighting—M. Pleason.
Available Colors—M. Pleason.
Specific Suggestions for Entrances, Corridors, Stairways and Offices—Lucille K. McGuire.
Specific Suggestions for Classrooms—Lucille K. McGuire.
Specific Suggestions for Special Purpose Rooms—Lucille K. McGuire.
Pointers — A Final Check — Lenore Linehan, Art Instructor.
Selected Bibliography — Edah F. Burnett, St. Paul Public Library.

This manual may be obtained from St. Paul Dept. of Education, Attention of W. C. Davini, Div. of Business Affairs, St. Paul Minn. The price is $2.00 per copy.

An interesting Section project is an 8-page pamphlet published by the Southern California Section of I.E.S., *What Is Good Lighting for Classrooms?* The booklet constitutes a quiz on school classroom lighting, with pertinent questions calling for yes or no answers and a scoring system designed to evaluate how good (or bad) a school's existing lighting may be. A brief discussion on the factors involved in good lighting for classrooms follows the quiz. One section of the booklet, which is very attractively presented and illustrated, gives suggestions and recommendations for classroom lighting, covering general lighting, interior finish, chalkboards, artificial lighting,

natural lighting and typical plans for lighting installations.

Write to Leonard W. Towner, Chairman, Southern California Section, 2471 Woodlyn Rd., Pasadena 7, Calif.

The Fleur-O-Lier Index System for specifying lighting performance, for rating fluorescent lighting fixtures and presenting Fleur-O-Lier specifications and testing procedures, has just been released by the Fleur-O-Lier Manufacturers Association. The brochure introduces a specification and rating system for use by illuminating engineers, architects and others to express their recommendations as to light distribution, shielding zone, brightness, etc. It is designed also for use by manufacturers, to identify and authenticate the performance characteristics of their luminaires, and by buyers of fluorescent lighting equipment to make certain the fixtures they buy will provide the performance that has been specified.

The brochure on the Fleur-O-Lier Index System is available from Fleur-O-Lier Manufacturers, 2116 Keith Bldg., Cleveland 15, Ohio.

The well-known text book on stage lighting, *A Method of Lighting the Stage*, by Stanley M. McCandless, has recently gone into a third edition, newly revised and illustrated. The book, long recognized by producers and theatre technicians as required study for their field, treats not only the theories of stage lighting, its emotional or comic possibilities and their effect on a scene, but also the technical methods by which these qualities can be obtained. The new edition brings many technical details up-to-date, has a number of new illustrations, and the overall size is enlarged so that it will be more useful in the study or classroom. *A Method of Lighting the Stage* is published by Theatre Arts Books, 63 West 44th St., New York 18, N. Y. and costs $2.50.

The late P. J. Bouma's last work, *Physical Aspects of Colour*, has recently been translated from the Dutch by W. De Groot, and is available in this country from the Elsvier Publishing Company, Inc., 215 Fourth Ave., New York 3, N. Y. In the maze of treatises on the characterization of colors, Bouma, in prose of great charm, has pointed out a well-defined course. Starting from the established laws of color mixing he gives an insight into the origin and perception of colors in a systematic manner. The author has succeeded in casting the subject matter in such a form that it may well enrich the knowledge of scientists working in aspects of this field. As a study of problems of chromatics students of the book would be presumed to have knowledge of mathematics and physics. The book is priced at $5.50.

NEW MEMBERS

At the meetings of Council held on December 8, 1948 and the Council Executive Committee held January 17, 1949, the following were elected to membership:

British Columbia Chapter

Associate Members: R. J. MacLennan, F. H. Palmer.
Student Member: J. M. Davison.

Capital Section

Member: C. W. Bogan.
Student Member: A. A. O'Brien.

Central New York Chapter

Associate Members: C. F. Bronner, V. O. Farber, L. W. Hall, N. P. McGowan.
Student Member: La Verne H. Hardy.

Chicago Section

Associate Members: S. A. Carver, F. P. Cumins, E. R. Hunt, N. G. Klein, P. S. Kreis, T. L. D. Lynxwiler, J. C. Maloney, G. G. Nordeen, L. K. Shoenbrod, C. J. Ticho, J. R. Wessling.
Student Members: N. Brim, C. T. Frey, J. H. Gusman, W. E. Hayes, R. L. Herr, Joan L. Hessler, P. W. Larsen, R. C. Schneider, E. H. Witte.

Cleveland Section

Member: C. G. Wing.
Associate Members: W. S. Fischer, Jr., J. R. Murphy, Jr., C. F. Peterson.
Student Members: P. H. Greenlee, C. B. Gynn, J. F. Lowenstein.

Connecticut Chapter

Members: C. W. McCormick, R. S. Rogge.

Cornhusker Chapter

Members: F. E. Foster, E. J. Pardun, C. R. Tracy.
Associate Members: C. L. Neill, H. W. Larson, R. W. Staal.

Domestic Non-Section

Members: Collin Finney, S. B. Le Cornu, E. E. Parks, W. B. Taylor.
Associate Members: M. S. Cone, S. S. Lawrence, T. N. Phillips, W. H. Ridley, B. R. Womack.

Eastern Pennsylvania Chapter

Associate Members: David Jae, E. S. Sheets, G. D. Wagonner.

Foreign Non-Section

Member: Prof. Georg Weber.

Georgia Chapter

Associate Members: E. A. Brown, R. D. Carlen, C. A. Hausman, P. N. Littlefield, Edwin H. Smith.

Hamilton, Ontario Chapter

Associate Members: J. D. Harrison, C. F. Irons, G. S. Izatt, W. A. McLeod, L. T. Spalding.

Heart of America Section

Associate Members: I. J. Hedges, Harvey Owings, Jr., S. T. Price, J. O. Schmitz.

Indiana Chapter

Associate Members: Cecil Adams, J. C. Blair, D. J. Cooper, A. E. Gravemeyer, C. E. Hamm, H. K. Keller, T. P. Messick, W. W. Nentrup, N. F. Schnitker.

Michigan Chapter

Member: James L. Culp.
Associate Members: Nanette Carnahan, J. O. Coit, Jr., Anthony Fodell, H. J. Hagen, H. M. Hemphill, Homer H.

Ottawa Chapter officers. Meeting to plan year's activities are: first row — Harold Ainsworth; W. B. Fulton, Secretary; W. J. Montabone; D. S. Robertson; Chairman, W. E. Reny; Major G. D Mills. Second row — S. G. Brooks; A. Haltrecht; H. D. Brown; R. S. Wright; G. M. Demers;

Parker, R. Douglas Shaw, R. M. Spray.

MILWAUKEE CHAPTER
Member: C. George Extrom.
Associate Members: R. L. Cunningham, Joseph L. Price, J. F. Herbenar.

MONTREAL SECTION
Members: D. W. Heywood, C. T. Roberts, D. Roland Webb.
Associate Members: A. Dutton, Albert Leduc, W. L. Stewart, R. S. Tate.

NEW ENGLAND SECTION
Associate Members: B. D. Barry, Jr., H. L. Colbeth, Jr., Dorothy G. Cooley, J. R. Cornell, Jr., V. A. Noel, Jr.

NEW ORLEANS CHAPTER
Member: B. J. Pridaux.
Associate Members: H. A. Germann, Jr., Albert A. Levin.

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Associate Members: Robert Bernstein, R. A. Johnson, W. H. Keen, Erwin Marquit, Samuel C. Miller, W. R. Wilson, B. N. Yanow.
Student Member: Joan L. Levine.

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Associate Members: I. M. Bush, S. M. Cameron, John H. Fatz, S. N. Mills, T. E. Murray, L. D. Shank.

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Associate Member: J. V. Walton.

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SOUTHWESTERN SECTION
Member: Thomas J. Lynn.

TORONTO SECTION
Members: W. D. Hannah, F. E. Barker, J. B. Merrifield, W. A. Trott.
Student Member: I. C. Percy.

TWIN CITY SECTION
Member: R. H. Hamilton.
Associate Members: E. V. Bergstrom, George M. Smith, R. P. Talbot.

UTAH CHAPTER
Associate Members: Harry E. Lewis, Benjamin T. Clark.

WESTERN NEW YORK SECTION
Associate Member: Harold Kirschenbaum.

Current Articles on Lighting

The following list presents titles and source of publication of current articles on lighting and allied subjects which have appeared in recent issues of nationally known magazines having a wide circulation.

Cold Cathode Lighting Progress in Hungary, *Signs of the Times*, January 1949, p. 105.

Cold Cathode Chosen by Engineering Firm, *Signs of the Times*, January 1949, p. 106.

Brooklyn Trolley Buses Lighted by Cold Cathode, *Signs of the Times*, January 1949, p. 108.

Sylvania Lighting Center Features Home Lighting, *Signs of the Times*, January 1949, p. 110.

Among the Unusual in Cold Cathode Installations, *Signs of the Times*, January 1949, p. 112.

Manual of Lighting Fixture Design, by Edwin D. Tillson, *Lighting and Lamps*, November 1948, p. 38.

Lighting Dramatizes Selling in Burdine's Fort Lauderdale, Fla., *Lighting and Lamps*, November 1948, p. 40.

Light for Our Aging Workers, *Better Light, Better Sight News*, Volume 16, Number 7, p. 6.

Using Color to Lighten Schoolwork and Brighten Dispositions, *Better Light, Better Sight News*, Volume 16, Number 7, p. 8.

Good Lighting Helps Ease Burden for Homemakers with Heart Ailments, *Better Light, Better Sight News*, Volume 16, Number 7, p. 11.

How to Switch Early Morning Street Lighting, *Electrical World*, November 20, 1948, p. 106.

Louverall Lighting Systems, by J. R. Chambers and E. H. Church, *Electrical Construction and Maintenance*, November 1948, p. 62.

Modern Lighting, *Electrical Construction and Maintenance*, November 1948, p. 147.

A Modern Shoe Store, by R. J. Radcliffe, *I.E.S. Lighting Review*, October 1948, p. 2.

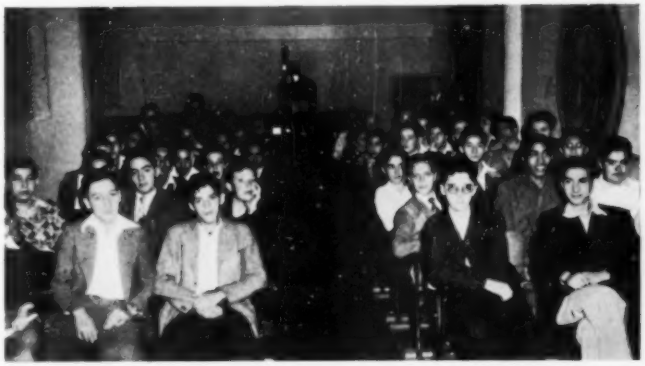
Lighting in Cove and Cornice, A. E. Reynolds, *I.E.S. Lighting Review*, October 1948, p. 4.

The Natural Lighting of Industrial Buildings, *I.E.S. Lighting Review*, October 1948, p. 15.

Porch Lighting Without Glare, by H. E. Wichers, *I.E.S. Lighting Review*, October 1948, p. 20.

Colonial Installations Show Versatility in Application of Cold Cathode Light-

(Continued on page 15A)



Students in Mexico City schools attend lighting lectures at Mexican Lighting Institute. Some 1500 school children have heard lighting talks designed for their interest.

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New Orleans Chapter—Southern Region

CHAIRMAN — HUTSON COLCOCK, 616 Baronne St., New Orleans 13, La.
SECRETARY — R. C. PASLAY, Louisiana Power & Light Co., 142 Delaronde, New Orleans 14, La.

Northern California Section— South Pacific Coast Region

CHAIRMAN—SAMUEL H. HAZELTON, JR., General Electric Co., 1614 Campbell St., Oakland 7, Calif.
SECRETARY—STANTON M. BLACKSMITH, Route 1, Box 173, Walnut Creek, Calif.

New York Section— Northeastern Region

CHAIRMAN—MISS CAROLINE E. HORN, Electrical Testing Laboratories, Inc., East End Ave. and 79th St., New York 21, N. Y.
SECRETARY—CARROLL O'SHEA, General Electric Co., 570 Lexington Ave., New York 22, N. Y.

Ohio Valley Section—
Great Lakes Region

CHAIRMAN—WILLIAM J. WILFERT, Wilfert Electric Co., 5521 Carthage Ave., Norwood 12, Ohio.
SECRETARY—ROBERT W. BROWN, Cincinnati Gas & Electric Co., 4th & Main Sts., Cincinnati 1, Ohio.

Oregon Section—
Pacific Northwest Region

CHAIRMAN — ROBERT E. LANCE, Eoff Electric Co., 509 N.W. 10th Ave., Portland 9, Oregon.
SECRETARY—CHAS. M. GATES, Portland General Electric Co., 621 S. W. Alder St., Portland 5, Oregon.

Ottawa Chapter—Canadian Region

CHAIRMAN—D. S. ROBERTSON, 126 Faraday St., Ottawa, Ont., Canada.
SECRETARY — W. B. FULTON, Northern Electric Co., Ltd., 203 Sparks St., Ottawa, Ont., Canada.

Philadelphia Section—
East Central Region

CHAIRMAN — GEORGE E. SHOEMAKER, Ithan, Pa.
SECRETARY—FRED M. PYLE, Gill Glass & Fixture Co., Amber and Tioga Sts., Philadelphia 34, Pa.

Pittsburgh Section—
East Central Region

CHAIRMAN — HARRY RESTOFSKI, West Penn Power Co., 14 Wood St., Pittsburgh 30, Pa.
SECRETARY — BYRON W. TOWNSEND, General Electric Co., Oliver Bldg., Pittsburgh 22, Pa.

Puget Sound Section—
Pacific Northwest Region

CHAIRMAN — K. E. HOLLINGSWORTH, Puget Sound Power & Light Co., 5562 Stuart Bldg., Seattle 1, Wash.
SECRETARY — BYRON G. LIND, 2015 Boylston Ave., N. Seattle 2, Wash.

Rochester Chapter—
Great Lakes Region

CHAIRMAN—L. C. TWITCHELL, Rochester Gas & Electric Co., 89 East Ave., Rochester 4, N. Y.
SECRETARY—N. T. KRIDEL, Rochester Gas & Electric Co., 89 East Ave., Rochester 4, N. Y.

Rocky Mountain Chapter—
Southwestern Region

CHAIRMAN—LYLE M. BAILEY, 774 Ash St., Denver 7, Colo.
SECRETARY—LEIGH CONGDON, Rite Lite Supply Co., 716 W. Colfax, Denver 4, Colo.

St. Louis Section—Midwestern Region

CHAIRMAN — HENRY ARENDES, Butler Elecric Co., 2832 Washington Ave., St. Louis 3, Mo.
SECRETARY—JOHN P. GARESCHE, 6311 Washington Blvd., St. Louis 5, Mo.

Southern California Section—
South Pacific Coast Region

CHAIRMAN — LEONARD W. TOWNER, 2471 Woodlyn Rd., Pasadena 7, Calif.
SECRETARY—ROBERT G. KNOPP, Phoenix Glass Co., 832 W. 5th St., Los Angeles 13, Calif.

South Texas Chapter—
Southwestern Region

CHAIRMAN — GEORGE B. JAMISON, Crouse-Hinds Co., 2801 San Jacinto St., Houston 4, Texas.
SECRETARY—WARREN O. CLARK, Phelps Dodge Corp., 933-A M & M Bldg., Houston 2, Texas.

Southwestern Section—
Southwestern Region

CHAIRMAN — H. B. SUDEKUM, General Electric Supply Corp., 1811 N. Lamar St., Dallas 2, Texas.
SECRETARY — NORVAL O. REED, Dallas Power & Light Co., Dallas 1, Texas.

Toronto Section—Canadian Region

CHAIRMAN—H. CECIL JONES, Canadian General Electric Co., Ltd., 212 King St., W., Toronto 1, Ont., Canada.
SECRETARY—DOUGALD W. PATTERSON, Amalgamated Electric Corp., 384 Pape Ave., Toronto, Ont., Canada.

Twin City Section—Midwestern Region

CHAIRMAN — JOHN O. KVALSTEN, Kvalsten Electric Co., 110 S. Fourth St., Minneapolis 1, Minn.
SECRETARY — R. H. HAMILTON, 5336 Drew Ave. S., Minneapolis, 10, Minn.

Utah Chapter—
South Pacific Coast Region

CHAIRMAN—J. VERNON SHARP, Sharp Electric Co., 128 S. State St., Salt Lake City 1, Utah.
SECRETARY — HAROLD R. TRIPP, Utah Power & Light Co., P.O. Box 899, Salt Lake City 10, Utah.

Western New York Section—
Great Lakes Region

CHAIRMAN — B. ALFRED THOMAS, General Electric Co., 901 Genesee Bldg., Buffalo 2, N. Y.
SECRETARY — RAYMOND P. CONNORS, 778 Starin, Kenmore, N. Y.

LOCAL REPRESENTATIVES

Canadian Region

Calgary, Alberta—H. J. McEwan, Canadian Westinghouse Co., Ltd.

Halifax, Nova Scotia—Victor Oldham, Canadian General Electric Co., Ltd.

London, Ontario — W. S. Hardman, Service Lamp Co., Ltd.

Moncton, New Brunswick—W. F. McElman, P. O. Box 404

Quebec, Quebec—G. A. Watters, Quebec Power Co.

St. John, New Brunswick—D. Roland Webb, The Webb Electric Co.

Windsor, Ontario—W. A. Shaw, Windsor Utilities Commission, Hydro Div.

Winnipeg, Manitoba — Edmund F. Wilson, Northern Electric Co., Ltd.

East Central Region

Allentown, Pa. — Francis E. Glick, Pennsylvania Power & Light Co.

Altoona, Pa.—Robert J. Nophsker, Pennsylvania Electric Co.

Bellaire, Ohio—C. L. Bullock, Ohio Power Co.

Bethlehem, Pa.—E. W. Halteman, Pennsylvania Power & Light Co.

Blacksburg, Va.—Claudius Lee, Virginia Polytechnic Institute

Charlottesville, Va.—L. L. Holladay, 434 Brandon Avenue

Easton, Pa.—D. A. Wismer, Metropolitan Edison Co.

Erie, Pa.—Joseph L. Warfel, Pennsylvania Electric Co.

Hanover, Pa.—Edward H. Blettner, Metropolitan Edison Co.

Harrisburg, Pa.—Richard D. Howe, R. D. #2

Hazleton, Pa.—Howard J. Kreitzberger, Pennsylvania Power & Light Co.

Johnstown, Pa.—Howard E. Ross, R. D. #4, P. O. Box 324

Lancaster, Pa.—Ford M. Gochenauer, Pennsylvania Power & Light Co.

Lebanon, Pa.—Charles C. Russell, Jr., Metropolitan Edison Co.

Lexington, Va.—J. S. Jamison, Jr., Virginia Military Institute

Morgantown, W. Va.—William C. Wade, Monongahela West Penn Public Service Co.

New Castle, Pa.—R. L. James, Pennsylvania Power Co.

Newport News, Va.—Clarence P. Andrew, Noland Co.

Pottsville, Pa.—Rolland W. Rodgers, Pennsylvania Power & Light Co.

Reading, Pa.—Frank E. Heins, Metropolitan Edison Co.

Richmond, Va.—George E. Schraudt, Jr., 812 St. Christopher Rd.

Scranton, Pa.—Frank B. Moore, General Electric Supply Corp.

Shenandoah, Pa.—Harry T. Weidman, Pennsylvania Power & Light Co.

State College, Pa.—David L. Markle, Pennsylvania State College

Sunbury, Pa. — William H. Heim, Pennsylvania Power & Light Co.

Towanda, Pa.—C. T. Troy, Northern Pennsylvania Power Co.

Wheeling, W. Va.—G. F. Morgan, Wheeling Electric Co.

Wilkes-Barre, Pa.—John G. Henninger, P. O. Box 1348

Williamsport, Pa. — Gleason E. Solley, 1103 Isabella St.

York, Pa.—Laurence O. Buckner, Metropolitan Edison Co.

Great Lakes Region

Akron, Ohio—Malcolm V. Tillett, Ohio Edison Co.

Alliance, Ohio—John R. Sweeney, Ohio Public Service Co.

Ashland, Ky.—G. S. Dunn, P. O. Box 1210

Ashtabula, Ohio — John E. Lundi, Cleveland Electric Illuminating Co.

Binghamton, N. Y.—Earl C. Edwards, New York State Electric & Gas Corp.

Canton, Ohio—E. A. Berry, The Ohio Power Co.

Corning, N. Y.—John P. Hoxie, Corning Glass Works

Dayton, Ohio—Henry H. White, 1304 Harvard Blvd.

Elyria, Ohio — G. C. Rubenson, Ohio Public Service Co.

Flint, Mich. — Harold P. Earley, Consumers Power Co.

Fostoria, Ohio—Ira J. Barber, 446 Fremont Dr.

Frankfort, Ky.—Meredith McKinney, P. O. Box 165

Fremont, Ohio—H. A. Gavitt, 2131 S. Buckland Ave.

Greenville, Ohio—Paul N. Young, 221 N. Main St.

Huntington, W. Va.—William M. Langstaff, Appalachian Electric Power Co.

Jackson, Mich. — Leslie D. Lyon, Consumers Power Co.

Lexington, Ky.—Robert W. Wilson, Kentucky Utilities Co.

Lima, Ohio—C. F. Daugherty, The Ohio Power Co.

Louisville, Ky.—Ray F. Tillman, The Brecher Co.

Mansfield, Ohio—Orlo L. Smith, Ohio Public Service Co.

Marion, Ohio—LeRoy W. Clauer, Marion Reserve Power Co.

Massillon, Ohio—Jesse R. Parsons, Ohio Public Service Co.

Newark, Ohio—Kurt Franck, Holophane Co., Inc.

Portsmouth, Ohio—J. Richardson Thomas, 1911 Franklin Ave.

Sandusky, Ohio—C. H. Smith, Ohio Public Service Co.

Saginaw, Mich.—Earl R. Domoney, Consumers Power Co.

Toledo, Ohio—E. F. Schmidt, Toledo Edison Co.

Utica, N. Y.—Raymond F. McGuinnes, Central New York Power Corp.

Warren, Ohio—Walter C. Schultz, Ohio Public Service Co.

Westerville, Ohio—Fred B. MacRae, 6908 S. State Rd.

Youngstown, Ohio — John G. Stewart, Ohio Edison Co.

Midwest Region

Cedar Rapids, Iowa—J. C. Young, Jr., 2400 "E" Ave., N. E.

Davenport, Iowa—F. C. Horton, General Electric Co.

Des Moines, Iowa—G. G. Fletcher, 3103 University Ave.

Dubuque, Iowa — Frank E. Bescher, 1410 Parkway

Duluth, Minn. — M. G. Braden, Minnesota Power & Light Co.

Evansville, Ind.—Ned S. Muse, Graybar Electric Co.

Evansville, Ind.—R. M. Sly, Southern Indiana Gas & Electric Co.

Ft. Wayne, Ind.—N. G. Smoley, General Electric Co.

Hastings, Neb. — George D. Miller, Dutton-Lainson Co.

Lafayette, Ind. — A. M. Smith, Kirby Risk Electric Co.

Lincoln, Neb.—D. J. Maynard, Korsmeyer Co.

Madison, Wis.—Arthur J. Von Burg, Wisconsin Power & Light Co.

Mason City, Iowa—Richard J. Hughes, 22½ Third St., N.E.

Muncie, Ind. — John A. Hand, Indiana & Michigan Electric Co.

Norfolk, Neb. — Dwight I. Hultman, 1206 Prospect Ave.

North Platte, Neb.—S. W. Snell, Snell Electric Co.

Omaha, Neb.—Ford E. Foster, Electric Fixture & Supply Co.

Peoria, Ill.—James F. Orr, Jr., General Electric Co.

Richmond, Ind.—A. Fentress Tucker, Municipal Electric Lighting & Power Plant

Rockford, Ill.—J. B. Johnson, 1611 Grant Avenue

Sioux City, Iowa—Charles R. Tracy, Sioux City Gas & Electric Co.

South Bend, Ind.—L. F. Stauder, 802 St. Vincent St.

Springfield, Ill.—J. Walter Marquardt, 400½ E. Adams

Urbana, Ill.—J. O. Kraehenbuehl, University of Illinois

Waterloo, Iowa—J. C. Gehan, 711 Lime St.

Wichita, Kansas — Arthur L. Harris, Kansas Gas & Electric Co.

Northeastern Region

Albany N. Y. — C. D. Hollister, New York Power & Light Corp.

Augusta, Maine—F. R. Gethro, Central Maine Power Co.

Bridgeport, Conn. — Kenneth Priestley, The Eastern Electric Construction Co.

Lowell, Mass.—Frank H. Jones, The Lowell Electric Light Corp.

Manchester, N. H. — Jack L. Calpin, Public Service Co. of New Hampshire

New Britain, Conn. — Timothy J. Clare, 376 Chestnut St.

New Haven, Conn.—Fred R. West, Westinghouse Electric Corp.

Norwalk, Conn.—H. A. Hutchinson, Connecticut Light & Power Co.

Pawtucket, R. I.—Walter L. Kelley, Jr., 77 Bayley St.

Pittsfield, Mass.—Charles T. Masterson, General Electric Co.

Rutland, Vt. — George Blackburn, Central Vermont Public Service Corp.

Springfield, Mass.—Jack O. Callander, Western Massachusetts Electric Co.

Waterbury, Conn.—R. O. Mills, 19 Maynard Ave.

Worcester, Mass.—W. S. Mowry, Worcester County Electric Co.

Pacific Northwest Region

Boise, Idaho—Orland C. Mayer, Idaho Power Co.

Butte, Montana—John W. Cromer, The Montana Power Co.

Victoria, British Columbia—Percy F. Fletcher, Canadian General Electric Co., Ltd.

Southern Region

Birmingham, Ala.—E. B. Richey, Comer Bldg. Charlotte, N. C.—Roy Palmer, Duke Power Co.

Chattanooga, Tenn.—Buford H. Martin, Tennessee Valley Authority

Pensacola, Fla.—A. M. Quarterman, Younge and Hart, Architects and Engineers.

South Pacific Coast Region

Fresno, Calif.—J. E. Hammond, Route 1, Box 559

Phoenix, Ariz.—A. W. Smith, Central Arizona Light & Power Co.

Reno, Nevada—F. W. Steiner, Jr., P. O. Box 2171

San Diego, Calif.—A. I. Benedict, San Diego Gas & Electric Co.

Southwestern Region

Amarillo, Texas—W. D. Knight, Southwestern Public Service Co.

Beaumont, Texas — Clarence B. Barron, Gulf States Utilities Co.

Corpus Christi, Texas—B. L. Guess, Jr., 1210 York Ave.

Oklahoma City, Okla.—T. M. Richardson, McEldoroney & Son, Inc.

Pine Bluff, Ark.—R. P. Hill, Arkansas Power & Light Co.

Shreveport, La.—R. K. Lothrop, Southwestern Gas & Electric Co.

Tulsa, Okla.—T. C. Wier, 1907 W. 41st St.

Non-Section

Honolulu, Hawaii—Paul H. Anderson, Hawaiian Electric Co.

Honolulu, Hawaii—Grace C. Hamman, 2614 Kuahine Drive

Honolulu, Hawaii—Edward L. Ralston, Jr., Hawaiian Electric Co.

Mexico City, Mexico—Atilio Celis, Apartado 2766

I.E.S. COMMITTEES—1948-1949

As of January 12, 1949

Except as noted below, all committees are appointed by the President, subject to approval of the Council, and terminate at the time of the first Council meeting each new administration, in the month of October. The duties of each committee are indicated.

Lee E. Tayler, ex-officio member of all committees

STANDING COMMITEES

BOARD OF FELLOWS — To evaluate the eligibility of candidates for transfer to the grade of Fellow and recommend their election by Council.

Frank A. Hansen, Chairman, Western Institute of Light & Vision, 3407 Lowry Road, Los Angeles 27, Calif.

O. P. Cleaver — T. W. Rolph
H. H. Magdsick — Howard M. Sharp
E. D. Tillson

COUNCIL EXECUTIVE — To conduct the affairs of the Society between Council meetings.

Lee E. Tayler, Chairman, The Detroit Edison Co., 2000 Second Avenue, Detroit 26, Mich.

C. H. Goddard — E. M. Strong
A. H. Manwaring — Walter Sturrock

FINANCE—Direct supervision of the financial affairs of the Society, present annual report on its financial condition and make recommendations to Council as to investments of money and upon all specific appropriations.

C. C. Keller, Chairman, Holophane Company, Inc., 342 Madison Ave., New York 17, N. Y.

B. J. Jensen — George T. Bogard,
J. E. Mueller — E. M. Strong

GENERAL BOARD OF EXAMINERS—Evaluate the eligibility of applicants for admission to membership or transfer to the grade of Member and submit to Council their nominees for election to the grade of Member Emeritus.

R. C. Kinney, Chairman, Graybar Electric Co., Inc., 420 Lexington Ave., New York 17, N. Y.

George T. Bogard — E. M. Fahey

PAPERS — To procure, review and approve all technical papers and discussions thereof, for presentation before National Conferences of the Society.

Hoyt P. Steele, Chairman, Benjamin Electric Mfg. Co., Des Plaines, Ill.

Howard L. Wright, Vice-Chairman, Curtis Lighting of Canada, Ltd., 195 Wicksteed Avenue, Leaside, Toronto 12, Canada.

Charles I. Brady — Paul H. Hildebrand
Arthur A. Brainerd — Harry W. Horn
W. V. C. Foulks — Kirk M. Reid
R. M. Zabel

PUBLICATIONS—To be responsible for the procurement, review and approval of all material for the publications of the Society other than technical papers approved by the Papers Committee for presentation at National Conferences of the Society and their discussions, and committee reports, for which it will have publication responsibility only. Shall also be responsible for the editing, printing and business management of the publications of the Society.

E. C. Huerkamp, Chairman, Westinghouse Electric Corp., 1216 W. 58th Street, Cleveland 1, Ohio.

H. H. Magdsick, Vice-Chairman, General Electric Company, Nela Park, Cleveland 12, Ohio.

B. C. Cooper — R. G. Slauer
R. W. McKinley — R. W. Staud
F. I. Wilson

Sub-Committee on Advertising Sales

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Fred E. Guth — L. J. Rozier
L. A. Hobbs — J. S. Schuchert
J. L. Kilpatrick — C. C. Shotwell
B. D. Levaur — E. D. Stryker
Carter Lewis — B. K. Wickstrum
R. W. McKinley — F. I. Wilson

Editorial Content Sub-Committee

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Sub-Committee on Home Lighting Data Sheets

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Hugh P. Scott, Vice-Chairman, McGraw-Hill Publishing Co., 330 W. 42nd Street, New York 18, N. Y.

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Charles R. Long

GENERAL COMMITTEES

BOARD OF NOMINATION

A. F. Wakefield, Chairman, The F. W. Wakefield Brass Co., 731 S. Water Street, Vermilion, Ohio

G. K. Hardacre	R. W. Staud

CONSTITUTION AND BY-LAWS — To prepare for Council amendments to the Constitution and By-Laws, as required, and to develop rules of procedure for the operation of the Society.

R. W. Corwin, Chairman, Benjamin Electric Mfg. Co., 230 W. 17th Street, New York 11, N. Y.

A. A. Brainerd	L. H. Graves
D. P. Caverly	A. F. Wakefield
B. C. Cooper	

DEFENSE, COORDINATING COMMITTEE FOR — To contact various Government Agencies concerned with National Security sugesting cooperation and participation in specific projects as an aid to solution of their problems. Recommending the placement of lighting study projects in present committees or the appointment of study project committees to the Society President and to expedite such study projects and guide accepted reports into proper Governmental channels.

A. F. Wakefield, Co-Chairman, The F. W. Wakefield Brass Co., 731 S. Water Street, Vermilion, Ohio.

Major G. D. Mills, Co-Chairman, 283 Osborne Avenue, Britannia Heights, Ottawa, Ont., Canada.

O. P. Cleaver	R. G. Slauer
C. L. Crouch	Walter Sturrock
S. L. Drumm	M. N. Waterman
G. A. Fry	C. S. Woodside
Paul Manchester	

LIGHTING SERVICE — To stimulate the discussion and practical application of lighting recommendations, standards, test procedures and other technical and scientific data developed by the Society to regional and local committees and to conduct a Lighting Service Forum in connection with the National Technical Conference.

J. M. Stodman, Chairman, Pennsylvania Power & Light Company, 901 Hamilton Street, Allentown, Pa.

Harold H. Green, Vice-Chairman, General Electric Co., Nela Park, Cleveland 12, Ohio.

A. I. Benedict	I. L. Illing
R. W. Butts	Frank E. Mueller
Maxwell Cole	Philip Peeples
Ralph R. Enghouser	George M. Rankin
H. B. Gould	W. A. Stannard
M. A. Havenhill	C. A. Stevens
C. D. Hollister	H. A. Stroud
H. Leland Holtman	Charles R. Tracy
H. G. Hrivnatz	L. C. Twitchell

LOCAL ACTIVITIES — To coordinate regional and local activities with the national program of the Society, assist Section and Chapter officers with local operating problems, conduct Local Activities Conferences, prepare plan to give members a better understanding of the Society, review applications for establishment of new Sections and Chapters and recommend the appointment of local representatives.

Walter Sturrock, Chairman, General Electric Company, Nela Park, Cleveland 12, Ohio.

E. E. Ackland	Edwin H. Lauth
G. W. Beals	Theodore H. Shepherd
R. L. Biesele, Jr.	William A. Stannard
Harry Grattan, Jr.	J. F. Whitehead, Jr.

Duncan M. Jones

MEDAL AWARD—To consider qualifications of candidates for I.E.S. Medal; submit recommendations to Council, and prepare citation for the reward.

A. F. Wakefield, Chairman, The F. W. Wakefield Brass Co., 731 S. Water St., Vermilion, Ohio.

G. W. Beals	W. F. Little
W. C. Brown	R. W. Staud
George G. Cousins	Dean M. Warren
L. H. Graves	S. B. Williams
G. K. Hardacre	

MEMBERSHIP—To develop plans and supervise the operation of the individual membership campaign in the Society.

Frank R. Knowles, Chairman, Pennsylvania Electric Co., 535 Vine Street, Johnstown, Pa.

Garlan Morse, Vice-Chairman, Sylvania Electric Products, Inc., 60 Boston Street, Salem, Mass.

James H. Hull, Vice-Chairman, Fostoria Industrial Service, 22 Davidson Building, Des Moines 9, Iowa.

Section and Chapter Representatives

F. R. Adair	E. Craig Jones
A. Anderberg	William F. Kratt
A. R. Ardinger	Howard Long
Frank A. Bettis	G. H. Maize
H. E. Bracke	William McGuire
W. B. Campbell	A. H. McKillop
G. M. Domers	Arthur H. Molitor
J. F. Dickerhoff	F. H. Owen
Walter C. Fink, Jr.	Edward M. Reid
Rush B. Glick	C. A. Rost
Paul J. Harrison	J. J. Sanders
Edward D. Heintze	W. J. W. Smith
B. T. Heinz	E. W. Thompson
B. O. Horton	H. M. White
Dean N. Jenks	Lester T. Wilcox

Edwin W. Wismer

NATIONAL TECHNICAL CONFERENCE —To supervise the 1949 Technical Conference, select the time and place for the 1950 and 1951 Technical Conference and act as a depository of invitations for future conferences; study and report to Council the possibility of holding periodically a nationally sponsored technical conference for the Pacific Coast Zone.

R. F. Hartenstein, Chairman, Ohio Edison Company, Akron 8, Ohio.

R. W. Butts, Vice-Chairman, The Ohio Public Service Co., 405 Broad Street, Elyria, Ohio.

R. R. Brady	D. W. Prideaux
W. C. Brown	T. H. Shepherd
J. H. Fall, III	R. G. Slauer
Harry Grattan, Jr.	J. M. Stedman
Fred Guth	Hoyt P. Steele
A. D. Hinckley	F. I. Wilson
C. C. Keller	

Conference Executive Committee

R. W. Butts, Chairman, Ohio Public Service Co., Elyria, Ohio.

Ross Brown, Vice-Chairman

W. J. Wilfert, Vice-Chairman

W. H. Kahler, Secretary

C. L. Amick	H. Leland Holtman
E. B. Bentley	F. A. Kolb
Robert W. Brown	C. W. McFee
L. W. Crotser	A. Fentress Tucker
Mary Wren Held	A. W. Wiese

PROCEDURES AND POLICIES — Analyze for Council procedures and policies and make recommendations.

G. K. Hardacre, Chairman, Public Service Co. of No. Illinois, 72 W. Adams Street, Chicago 3, Ill.

Ward Harrison	R. W. Staud
P. S. Millar	A. F. Wakefield

PROJECT PLANNING—To study the operations, programs and policies of the Society with the view of its immediate and long-range objectives and recommend to Council new projects and programs to be established.

J. S. Schuchert, Chairman, Duquesne Light Company, 435 Sixth Avenue, Pittsburgh 19, Pa.

W. C. Brown	N. D. MacDonald
C. H. Goddard	Ralph G. Raymond
L. H. Graves	Hoyt P. Steele
J. R. Hartman	W. F. White
Raymond C. Kinney	M. C. Wilt

PUBLIC RELATIONS AND INFORMATION—

J. M. Hickerson, Chairman, J. M. Hickerson, Inc., 110 E. 42nd Street, New York 17, N. Y.

H. H. Green	J. S. Schuchert
R. R. Hill	R. W. Staud
Duncan M. Jones	W. T. Stuart
L. J. Rozier	B. F. Stevens

RESIDENCE LIGHTING FORUMS—To reactivate and expand residence lighting forums, suggest programs for meetings, revise Guide for Residence Lighting Forums and conduct a National Residence Lighting Forum Conference in connection with the National Technical Conference.

Priscilla Presbrey, Chairman, Westinghouse Eilectric Corp., Bloomfield, New Jersey.

Mary E. Dodds	Ruth Morris
C. I. Dwinell	Florence O'Donnell
Lillian E. Eddy	Janet Reynolds
Myrtle Fahsbender	Margaret Salter
Harry Feldman	Mary Taepke
Caroline E. Horn	Mary E. Webber

SECTION AND CHAPTER PROGRAMS, COORDINATING COMMITTEE ON—To make a study of the subjects and topics of probable interest to our members, review previous section and chapter programs, and prepare a report of program suggestions for section and chapter meetings, technical forums and study clubs.

Carl A. Basedow, Chairman, 3425 N. Harding Avenue, Chicago 18, Ill.

C. L. Amick	R. R. Lusk
J. R. Chambers	C. D. Miller
F. A. Hansen	C. B. Pederson
J. L. Kilpatrick	C. C. Shotwell
G. E. Korten	R. E. Worstell

SUSTAINING MEMBERS—To obtain additional Sustaining Members.

George J. Taylor, Chairman, Day-Brite Lighting, Inc., 92 Liberty Street, New York 6, N. Y.

Urban L. Beh	Stuart Goodwillie
R. A. Corvey	W. E. Potter
W. E. Folsom	C. C. Shotwell
D. W. Fuller	F. I. Wilson
Noble Gery	

Members ex-officio acting as assistants to the Chairman

E. E. Ackland	Duncan M. Jones
G. W. Beals	Edwin H. Lauth
R. L. Biesele, Jr.	Theodore H. Shepherd
J. B. Browder	William A. Stannard
Harry Grattan, Jr.	

Section and Chapter Representatives

Earl H. Aik	Wallace P. Covington
H. J. Ashbee	Joseph T. Dupree
G. W. Beals	Theodore M. Foulk
Frank E. Bescher	D. William Fuller
James N. Brannan	Joseph R. Hartman
L. H. Brown	John P. Hobrecht
H. A. Cook	George M. Hooks
Berlon C. Cooper	Harold M. Horton

Harry G. Hrivnats
H. E. Ingraham
F. R. Jeffrey
Guy M. Jones
Henry R. Jones
Theodore C. Lauck
Carter Lewis
Thomas Lyda
Richard E. Magnell
W. J. Montabone
H. W. Osborne
Ellsworth E. Schwalm
J. Vernon Sharp
Hugh X. Sheeter
William J. W. Smith
Robert E. Steele
Percy B. Thorne
Walter A. Toly
B. A. Travis
D. E. Vincent
Clarence C. Walker
Thomas J. Whalen

TASK COMMITTEES

TASK COMMITTEE — JOINT I.E.S.-A.P.H.A. COMMITTEE — To discuss with A.P.H.A. objectives of mutual interest in illumination, to review the relationship of light and vision, to study a rational basis for the quality and quantity of illumination and develop a list of researches desirable for further knowledge and cooperative effort.

E. M. Strong, Chairman, Cornell University, Ithaca, New York.
Conrad Berens
E. C. Crittenden
C. L. Crouch

A.P.H.A. Representatives

Francis Elder
Leonard Greenburg
M. Allen Pond
Donald Y. Solandt

TASK COMMITTEE ON WARTIME LIGHTING PRACTICES DURING WORLD WAR II—To solicit, assemble and compile a record of studies and practices on dimouts, blackouts and defense lighting (including concealment, camouflage and other topics) related to World War II experience; to file such record in the I.E.S. headquarters.

O. P. Cleaver, Chairman, Corps of Engineers, Fort Belvoir, Va.
C. F. Cashell
C. I. Dwinell
S. G. Hibben
S. R. McCandless
Roy A. Palmer
Kirk M. Reid
F. J. Wellhouse
C. W. Zersen

TASK COMMITTEE ON CONFERENCE WITH THE NATIONAL COUNCIL FOR SCHOOLHOUSE CONSTRUCTION — To explore the field of mutual interest; to serve as a clearing house of expression regarding reports of both organizations; to study recommendations of quantity and quality of illumination and to develop a suggested program of study and research on specific illumination problems applying to schools.

R. C. Putnam, Chairman, Case Institute of Technology, 10900 Euclid Ave., Cleveland 6, Ohio
L. H. Brown
C. L. Crouch
W. V. C. Foulks

TECHNICAL COMMITTEES

AVIATION LIGHTING—To study the application of light and lighting to the spaces and functions involved in the operation of aircraft.

Ralph R. Brady, Chairman, Westinghouse Electric Corp., Bloomfield, N. J.
L. B. Moore, Vice-Chairman, The Grimes Manufacturing Co., Urbana, Ohio.
C. D. Miller, Secretary, General Electric Company, Nela Park, Cleveland 12, Ohio
H. Ainsworth
J. F. Angier
F. C. Ashe
J. B. Bartow
H. R. Blackwell
R. C. Blatt
F. B. Brady
F. C. Breckenridge
A. H. Clarke
G. K. Clement
D. I. Coggins
Roy E. Dahlin
W. T. Harding
J. P. Hoxie
F. B. Kemery
G. M. Kevern
A. L. Lewis
R. E. Madigan
W. E. K. Middleton
H. J. C. Pearson
W. A. Pennow
J. M. Roper
V. J. Roper
R. A. Rugge
J. Penn Rutherford
L. C. Simpson
D. H. Tuck
L. C. Vipond

COLOR AND ILLUMINATION—To study, evaluate and report on the effect of color in relation to the Art and Science of Illumination.

Dean Farnsworth, Chairman, U. S. Naval Submarine Base, Medical Research Laboratory, Box 45, New London, Conn.
A. A. Brainerd
R. L. Biesele, Jr.
Faber Birren
L. H. Brown
G. B. Buck II
C. L. Cottrell
G. F. Dean
Ralph M. Evans
Carl E. Foss
W. C. Granville
J. P. Guilford
S. H. Hazelton, Jr.
Harry Helson
W. H. Kahler
Johan C. Kromhout
H. L. Logan
Gladys Miller
Norman Macbeth
J. A. Meacham
Dorothy Nickerson
D. E. Spencer
A. H. Taylor
K. C. Welch

DAYLIGHTING—To study the problems involved in daylighting, develop recommended practices and report thereon.

W. C. Randall, Chairman, Detroit Steel Products Co., 2250 E. Grand Blvd., Detroit 11, Mich.
H. Ainsworth
W. J. Arner
A. H. Baker
Frank Benford
R. L. Biesele, Jr.
L. H. Brown
H. S. Bull
C. W. Bursch
W. E. Folsom
Charles D. Gibson
B. F. Greene
J. S. Herbert
George N. Hingston
E. H. Hobbie
R. W. Hudson
F. L. Knowles
W. F. Little
J. A. Meacham
R. A. Miller
A. E. Parker
L. B. Perkins
F. W. Preston
S. W. Quisenberry
D. E. Spencer
J. P. Staples
H. B. Vincent
A. Vogel
George B. Watkins
Kenneth C. Welch

FARM BUILDINGS AND WORK AREA LIGHTING — To study the application of light and lighting of farm buildings, surrounding work areas and other rural locations and to report thereon.

O. D. Hunt, Chairman, Kansas State College, Manhattan, Kans.
T. M. Barr
Edith Buchholtz
J. P. Ditchman
P. H. Hildebrand
Joseph Schaenzer
A. J. Von Burg

ILLUMINATION PERFORMANCE RECOMMENDATIONS — To prepare Illumination Performance Recommendations comprising brightness distribution, output efficiencies and other pertinent photometric characteristics for luminaires conforming to I.C.I. classifications, excluding residential.

J. F. Parsons, Chairman, Buffalo Niagara Electric Corp., 802 Electric Building, Buffalo 3, N. Y.
G. R. Baumgartner
B. S. Benson, Jr.
W. H. Kahler
W. F. Little
Robert S. Rogge
R. P. Teele
G. P. Wakefield

INDUSTRIAL LIGHTING — To revise the 1942 "American Recommended Practice of Industrial Lighting" with full consideration to the brightness approach, and with Council approval, to submit for American Standards Association approval.

W. C. Brown, Chairman, General Electric Company, Nela Park, Cleveland 12, Ohio.
G. W. Beals
L. H. Brown
J. C. Forbes
C. C. Shotwell
Hoyt P. Steele
J. William Steiner
M. N. Waterman

LIBRARY LIGHTING—To study the application of light and lighting to public and institutional libraries and report thereon.

J. M. Ketch, Chairman, General Electric Co., Nela Park, Cleveland 12, Ohio.
H. A. Cook
E. M. Fahey
J. F. Fedeler
Francis Keally
Robert R. Wylie

LIGHT CONTROL AND EQUIPMENT DESIGN—Collect and correlate the knowledge and data on means and methods of controlling, directing, reflecting, transmitting, and diffusing light and on the principles and practices of equipment design.

F. C. Winkler, Chairman, Westinghouse Electric Corp., 1216 W. 58th Street, P.O. Box 5817, Cleveland 1, Ohio.
R. D. Bradley, Vice Chairman,
George Arras
G. R. Baumgartner
G. W. Beals
C. J. Berry
Kurt Franck
Charles N. Laupp
W. S. Mowry
John H. Waterbury
David L. Williams

Joint Sub-Committee on Plastics for Lighting

A. B. Oday, Chairman, General Electric Co., Nela Park, Cleveland 12, Ohio.
M. H. Bigelow
W. F. Little
W. P. Lowell, Jr.
L. Schepmoes
F. C. Winkler

LIGHT SOURCES—To correlate and report available information as to the physics of light and light production and the characteristics of current light sources.

A. B. Oday, Chairman, General Electric Co., Nela Park, Cleveland 12, Ohio.
E. F. Lowry, Vice-Chairman, Sylvania Electric Products, Inc., 126 Washington Street, Salem, Mass.
H. F. Davidson
Arthur C. Downes
G. S. Evans
B. F. Greene
J. O. Kraehenbuehl
Russell C. Putnam
Ellery H. Raddin
E. H. Salter

LIGHTING AND AIR CONDITIONING—To study the relationship between lighting and various factors that enter into air conditioning and report thereon.

Howard M. Sharp, Chairman, 82 Smallwood Drive, Synder 21, New York.
R. R. Lusk
E. H. Salter
C. L. Seaquist

Representatives of American Society of Heating and Ventilating Engineers

M. C. Beman

LIGHTING AND ARCHITECTURE—To study the application of light and lighting in the field of Architecture. To plan an interchange of knowledge and data between the Architectural profession and the Illuminating Engineering Society. To plan and develop lighting design competitions in Architectural Schools. To report to the Society on assignments falling within this scope.

H. E. D'Andrade, Chairman, General Electric Company, 570 Lexington Avenue, New York 22, N. Y.
Lucian T. Kight, Vice-Chairman, Duquesne Light Company, 435 Sixth Avenue, Pittsburgh 19, Pa.
J. H. Dean
E. M. Fahey
Dean H. Holden
David H. Mason
S. R. McCandless
Wentworth M. Potter
E. Rambusch
E. M. Steen
K. C. Welch

LIGHTING DESIGN PRACTICE — To study published data on coefficients of utilization, room indexes, maintenance coefficients and other elements entering into calculation for lighting design, and to develop and propose methods for use in Society publications.

Charles L. Amick, Chairman, General Electric Co., Nela Park, Cleveland 12, Ohio.
Willard Allphin
B. S. Benson, Jr.
J. H. Dean
Neal Jacobus
J. O. Kraehenbuehl
J. J. Neidhart
J. F. Parsons
R. S. Rogge
E. H. Salter
R. P. Teele

LIGHTING EDUCATION—To prepare educational and training programs on the fundamentals of illumination, lighting design problems and advance theories of light and lighting application. To prepare required text material and to further their adoption locally.

C. D. Miller, Chairman, Duquesne Light Co., 435 Sixth Avenue, Pittsburgh 19, Pa.
C. E. Weitz, Vice-Chairman, General Electric Company, Nela Park, Cleveland 12, Ohio.
W. D. Barnhizer
Warren B. Boast
C. W. Clarkson, Jr.
O. D. Hunt
W. B. Kennedy
Carter Lewis
Robert Ligare
Ralph Lusk
David H. Mason
S. F. McGowan
H. L. McKinley
J. F. Parsons
C. E. Robison, Jr.
H. A. Stroud
Carl W. Zersen

Joint Sub-Committee—I.E.S.-U.S. Public Health Service

Carl W. Zersen, Chairman, 241 S hiller Street, Elmhurst, Illinois.

B. S. Benson, Jr.
George D. Clayton
Don Ingwersen
R. E. Ligare
F. J. Marriett
R. R. Lusk
J. F. Parsons
Tula Salpus
A. A. Sobolik

Pictorial Presentation of Illumination Measurements and Terms

Carl W. Zersen, Chairman, 241 Schiller Street, Elmhurst, Illinois.
B. S. Benson, Jr.
F. H. Heintz
D. N. Ingwersen
R. E. Ligare
R. R. Lusk
F. J. Marriett
A. A. Sobolik

Prerequisites in the Profession

Aksel Knudstrup
R. C. Putnam
E. M. Strong
D. E. Trefry

Section and Chapter Representatives

Clark Baker, Jr.
J. A. Bartelt
Louis D. Black, Jr.
Russell A. Cook
J. F. Dougherty
W. C. Hird
C. N. Laupp
William K. LeBold
Arthur Mendel
J. F. Parsons
Edmund W. Pratt
John S. Walsh
A. J. Walter
Thomas J. Whalen
C. D. Willits
M. G. Zervigon

LIGHTING STUDY PROJECTS IN EDUCATIONAL INSTITUTIONS—To study the application of light and lighting to the spaces and processes involved in educational institutions; to initiate, follow up and coordinate lighting study projects in the educational field; review the reports of the various study committees in this field; and make recommendations to Council.
Russell C. Putnam, Chairman, Case Institute of Technology, University Circle, Cleveland 6, Ohio.

Carl J. Allen, Secretary, General Electric Company, Nela Park 12, Ohio.

Willard Allphin
R. L. Biesele, Jr.
L. H. Brown
John M. Chorlton
W. G. Darley
W. V. C. Foulks
S. K. Guth
Ray L. Hamon
L. V. James
W. H. Kahler
Charles N. Laupp
L. B. Paist
H. W. Schmidt
E. L. Stouffer
C. P. Tolman
R. R. Tracht

LIGHTING STUDY PROJECTS IN INDUSTRY—To initiate, follow up and coordinate lighting study projects in the industrial field, review the reports of the various subcommittees in this field and make recommendations to Council.

M. N. Waterman, Chairman, Westinghouse Electric Corp, Bloomfield, N. J.

J. R. Chambers
C. E. Egeler
C. D. Hollister
A. W. Larson
G. G. Rae
R. G. Slauer

Lighting in Bakeries

F. J. Vodicka, Chairman, Commonwealth Edison Company, 2233 S. Throop Street, Chicago 8, Ill.
F. C. Bing
W. B. Bradley
J. C. Weeks
G. C. Fowler

Lighting in the Canning Industry

Carl O. Martin, Chairman, Benjamin Electric Mfg. Co., 448 Bryant Street, San Francisco 7, California.
L. H. Brown
S. H. Hazleton, Jr.
K. M. Knoble
R. S. Prussia
Robert Thallon
H. K. Wilder

Lighting in the Fluid Milk Industry

O. A. Hill, Jr., Chairman, Public Service Co. of No. Illinois, 1701 S. First Avenue, Maywood, Illinois.

Lighting in Foundries

Frank E. Mueller, Chairman, 1296 Nicholson, Lakewood 7, Ohio.
C. W. Briggs
R. L. Collier
C. E. Egeler
J. H. Lansing
J. W. Steiner

Lighting in Laundries

O. A. Hill, Jr., Chairman, Public Service Co. of No. Illinois, 1701 S. First Avenue, Maywood, Illinois.
G. F. Allen
J. R. Chambers
A. L. Christensen
R. R. Hill
Carl F. Jensen
R. R. Lusk
W. S. E. Miller

Lighting in Leather Manufacturing

Edward J. White, Chairman, Edward J. White Company, 351 Broadway, Newark 4, N. J.
I. J. Chesley
B. J. Jensen
William G. Morrison
L. A. Robinson
George H. Scherer
R. W. Stanley

Lighting of Sheet Metal, Stamping, Folding and Shearing

Floyd W. Sell, Chairman, The Detroit Edison Company, 2000 Second Avenue, Detroit 26, Michigan.
Howard A. Boltz
E. L. Frase
J. M. Marlin
Ted Rougly

Lighting in Steel Mills

A. Paulus, Chairman, Westinghouse Electric Corp, 306 Fourth Ave., Pittsburgh 30, Pa.
J. J. Booth
C. M. Crysler
C. J. Enlind
H. Hargest
Lucian T. Kight
H. J. Mazur
Carlton Ostrom

Lighting in the Woolen Industry

(Joint committee with the A.S.M.E. on Lighting in the Textile Industry)

W. L. Kelley, Jr., Chairman, Blackstone Valley Gas & Electric Company, 55 High Street, Pawtucket, R. I.
Walter P. Rayner
J. M. Shute
F. J. Vorlander, Jr.
J. E. Watkins

Lighting for the Printing Industry

George W. Clarke, Chairman, Sylvania Electric Products, Inc., Washington, D. C.
W. A. Anderson
Peter Becker, Jr.
R. R. Bransdorf
C. C. Hayes
Z. T. Scheidt
B. J. Taymans
H. M. White

Supplementary Lighting

G. F. Dean
L. E. Goble
W. H. Kahler
E. A. Linsday

Study Assignment in Lighting Study Projects

L. J. Cahill
H. A. Cook
W. F. Carson
Leo Dolkart
W. D. Gorman
R. L. James
Aksel Knudstrup
W. S. Mowry
C. L. O'Shea
D. H. Tuck

LIGHTING STUDY PROJECTS IN PUBLIC BUILDINGS AND PRIVATE INSTITUTIONS—To initiate, follow up and coordinate lighting study projects in the field of public buildings and private institutions, review the reports of the various study sub-committees in this field and make recommendations to Council.
Robert R. Wylie, Chairman, Sylvania Electric Products, Inc., Lighting Fixture Division, Ipswich, Mass.
C. J. Berry
L. M. Endres
T. Fuchs
J. M. Ketch
Carter Lewis
James J. Oberhausen

Lighting in Auditoriums and Churches

David H. Mason, Chairman, 1415 W. Adams Street, Chicago 7, Illinois.
Louis Gold
Edward Rambusch
A. C. Sangster

Lighting in Hospitals

Hoyt S. Scott, Chairman, General Electric Co., Nela Park, Cleveland 12, Ohio.
H. W. Alexander
D. L. Angus
J. C. Connor
B. C. Cooper
Harry Grattan, Jr.
E. H. Greppin
J. J. Neidhart
Floyd W. Sell
Albert Zack

Hotel Lighting

Myrtle Fahsbender, Chairman, Westinghouse Electric Corp., Bloomfield, N. J.
G. F. Dean
Francis Keally
J. M. Ketch
Carter Lewis
Joseph P. Manucid
Gladys Miller
M. W. Ross
C. I. Sayles

Lighting in Theatres

C. M. Cutler, Chairman, General Electric Company, Nela Park, Cleveland 12, Ohio.
Eugene Braun
J. R. Cravath
Theodore Fuchs
J. S. Hamel
S. G. Hibben
Edward B. Kirk
Herbert Kliegl
James McCulloch
Edward Rambusch
Hunton D. Sellman
George Smedberg
Daniel Staehle
R. Gillespie Williams
Frederick M. Wolff

NOMENCLATURE—To define the terms and standards of illumination; and endeavor to obtain uniformity in nomenclature.
Allan E. Parker, Chairman, Worcester Polytechnic Institute, Worcester 2, Mass.
E. Q. Adams
E. W. Beggs
H. P. Gage
K. S. Gibson
L. A. Jones
J. O. Krachenbuehl
W. F. Little
M. Luckiesh
Harris Reinhardt
H. C. Rentschler
H. P. Steele

OFFICE LIGHTING—To study the lighting requirements of office lighting tasks, develop suitable lighting recommendations and report thereon.
R. L. Oetting, Chairman, General Electric Company, Nela Park, Cleveland 12, Ohio.
G. F. Dean Vice-Chairman, Toronto Hydro-Electric System, 14 Carlton Street, Toronto, Ont., Canada.
Lorin C. Brown
A. G. Elley
W. E. Folsom
G. C. Fowler
George J. Taylor
G. P. Wakefield

PROGRESS—To keep in touch with developments in the art of lighting throughout the world and prepare a yearly review of achievements in the art of illuminating engineering for inclusion in ILLUMINATING ENGINEERING.
S. G. Hibben, Chairman, Westinghouse Electric Corp., Bloomfield, New Jersey.
Alston Rodgers, Vice-Chairman, General Electric Company, Nela Park, Cleveland 12, Ohio.
A. C. Barr
E. W. Beggs
M. H. Bigelow
L. J. Buttolph
O. P. Cleaver
Paul D. Cornelisen
Walter J. Jones
Arthur P. Larson
David H. Mason
J. A. Meacham
R. G. Slauer
J. W. Steiner
A. S. Tylor

PUBLIC CONVEYANCES — INTERIOR LIGHTING—To study the application of light to all public areas in conveyances used for passenger transportation, including particularly trains, buses, ships, street railways, and subways and report thereon.
E. W. Beggs, Chairman, Westinghouse Electric Corp., Bloomfield, N. J.
A. L. Arenberg
Charles I. Brady, Jr.
E. E. Dorting
W. Fall
E. B. Hallman
J. L. Heine
H. H. Helmbright
J. C. de la Rosa
R. G. Slauer
L. J. Verberg
W. C. Wheeler
Randolph Whitefield

RESEARCH—To survey and report on all significant research dealing directly or indirectly with the application of light and lighting and its effect upon the performance and comfort of human beings not conducted by the I.E.S. Research Trust Fund, to survey the whole field of lighting to determine and report on subjects which require scientific verification through research, and to coordinate various types of research affecting lighting which are now being conducted by various agencies.
Dean H. Holden, Chairman, Nutplains, Guilford, Conn.
O. P. Cleaver
Hedley F. Davidson
S. McK. Gray
S. K. Guth
D. B. Harmon
H. L. Logan
G. F. Mudgett
S. R. Naysmith
E. M. Strong
Miles A. Tinker
Harry O. Warner
W. F. White

RESIDENCE LIGHTING — To study the application of light and lighting to the home including the study of the aesthetic phase of residential lighting, to prepare some practical reference for good lighting practices in period interiors and to report thereon.

E. W. Commery, Chairman, General Electric Company, Nela Park, Cleveland 12, Ohio.

Mary E. Dodds	Gladys Miller
Myrtle Fahsbender	Priscilla Presbrey
Katherine T. Goodall	D. L. Ripley
J. J. Jasin	Janet Reynolds
A. W. Kakilty	Mary E. Webber
Thomas S. Kelly	Norman Vacha
W. F. Little	

Color and Lighting

Gladys Miller, Chairman, 535 Fifth Ave., New York, N. Y.

Contemporary Lighting Practices in Traditional and Modern Interiors

Myrtle Fahsbender, Chairman, Westinghouse Electric Corp., Lamp Division, Bloomfield, N. J.
Gladys Miller
Janet Reynolds
Mary Webber

Cooperation with Residence Fixture Manufacturers

Norman Vacha, Chairman,

Lighting and Viewing Habits Associated with Television Receivers in the Home —Survey

Mary E. Dodds, Chairman,

Study Projects for Undergraduate Students

T. S. Kelly, Chairman, 115 East 60 St., New York, N. Y.

SPORTS AND RECREATIONAL AREA LIGHTING—To study the application of light and lighting to the areas and activities involved in sports and recreations and to report thereon.

Benjamin S. Benson, Jr., Chairman, Benjamin Electric Mfg. Co., Des Plaines, Ill.
R. J. Swachamer, Vice-Chairman, General Electric Company, 1 River Road, Schenectady 5, N. Y.

J. W. Bateman	Frank R. Jeffrey
Earle D. Benson	Merle E. Keck
H. E. Carney	J. Leroy Phillips
A. H. Clarke	Kirk M. Reid
J. G. Felton	M. W. Ross
A. B. Hallaway	Dana W. Rowten
T. E. Hammond	D. E. Trefry
H. F. Ilgner	F. D. Wyatt

Study Assignments in Sports and Recreation Lighting Study Projects

J. W. Bateman	P. N. Clerke
B. S. Benson, Jr.	

STANDARDS OF QUALITY AND QUANTITY FOR INTERIOR ILLUMINATION—To prepare standards for illumination levels, brightness limits, brightness ratios for interiors including specific visual tasks, as well as the general surroundings.

Louis E. Barbrow, Chairman, National Bureau of Standards, Washington 25, D. C.

Willard Allphin	Ward Harrison
M. E. Bitterman	H. L. Logan
H. R. Blackwell	D. L. Ripley
G. A. Fry	D. E. Spencer
S. K. Guth	E. M. Strong
LeGrand Hardy	

STORE LIGHTING—To study the application of light and lighting to the spaces and processes involved in the selling of goods and to report thereon.

M. W. Ross, Chairman, Commonwealth Edison Co., 72 W. Adams Street, Chicago 90, Ill.

R. C. Allison	W. E. Conley[1]
D. P. Caverly	George Gilleard
R. F. Hartenstein	G. H. Seiter
John J. Neidhart	K. C. Welch
W. M. Potter	R. W. Wyman
E. L. Riego	

STREET AND HIGHWAY LIGHTING—To establish the scientific principles underlying Street and Highway Lighting; to collect data on the results of the application of such principles to actual practice; to prepare such reports thereon as will assist technicians and benefit the public.

Stuart R. Williams, Chairman, Holophane Company, Inc., Newark, Ohio.
R. M. Zabel, Vice-Chairman, Westinghouse Lamp Division, Bloomfield, N. J.

J. W. A. Bollong	J. L. Kilpatrick
J. B. Browder	G. E. Korten
Nicholas Carter	A. H. Manwaring
G. G. Cousins	John F. McGough
W. L. Cross, Jr.	P. S. Millar
Warren Edman	J. J. Oberhausen
J. H. Fahey	O. P. Ortlieb
G. K. Glass	H. W. Osborne
C. A. B. Halvorson	Kirk M. Reid
G. K. Hardacre	C. H. Rex
L. F. Heckmann	D. W. Rowten
O. W. Holden	W. W. Sanders
R. M. Hoot	L. J. Schrenk
H. G. Hrivnatz	R. E. Simpson
H. F. Ilgner	R. G. Slauer
G. W. Izant	R. M. Swetland
Lloyd M. Johnson	G. A. Trosper
E. B. Karns	F. D. Wyatt

Study Assignments in Street and Highway Lighting Study Projects

George A. Eddy	W. H. Woods
Earl J. Tinsman	

Joint Sub-Committee, National Shade Tree Conference

O. P. Ortlieb, Chairman, Engineer of Street Lighting, 122 Municipal Building, Trenton 8, N. J.

R. M. Hoot	L. J. Schrenk
Kirk M. Reid	G. A. Trosper

Executive

Stuart R. Williams, Chairman
R. M. Zabel, Secretary

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C. A. B. Halvorson	Kirk M. Reid
H. F. Ilgner	C. H. Rex
J. L. Kilpatrick	J. L. Schrenk
G. E. Korten	F. D. Wyatt
P. S. Millar	

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J. L. Kilpatrick, Chairman

J. H. Fahey	L. F. Heckman
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Kirk M. Reid, Chairman

G. W. Izant	R. G. Slauer
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Dana W. Rowten	

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Howard F. Ilgner, Chairman

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G. G. Cousins	H. W. Osborne

Public Lighting and Traffic Safety

Louis J. Schrenk, Chairman

J. B. Browder	W. W. Sanders
W. L. Cross	R. E. Simpson

Pavement Surfaces and Safety Lighting

F. D. Wyatt, Chairman

C. A. B. Halvorson	Kirk M. Reid
H. W. Osborne	L. J. Schrenk

Forestation

Otto P. Ortlieb, Chairman

R. M. Hoot	L. J. Schrenk
K. M. Reid	G. A. Trosper

Special Committee on I.E.S. Lighting Handbook

George E. Korten, Chairman

J. F. McGough	Dana W. Rowten
P. S. Millar	R. G. Slauer
	R. M. Swetland

Special Committee on Recommended Practice

C. H. Rex, Chairman

W. H. Edman	H. F. Ilgner
G. K. Hardacre	L. M. Johnson
O. W. Holden	E. B. Karns
H. G. Hrivnatz	

Special Committee on Revision 1927 Report, "Principles of Street Lighting"

P. S. Millar, Chairman

A. F. Dickerson	K. M. Reid
H. F. Ilgner	D. W. Rowten

Special Committee on Interchange with Foreign Groups

W. H. Edman, Chairman

E. B. Karns	K. M. Reid
P. S. Millar	R. G. Slauer

Members at Large

W. H. Edman	G. E. Korten
C. A. B. Halvorson	P. S. Millar

TECHNICAL COMMITTEE FORUM—To coordinate procedures of our technical committees and to sponsor a lighting application symposium at the National Technical Conference.

C. H. Goddard, Chairman, Sylvania Electric Products, Inc., Ipswich, Mass.
E. W. Fowler, Vice-Chairman, Buffalo Niagara Electric Corp., Buffalo, N. Y.

E. W. Beggs	R. L. Oetting
B. S. Benson, Jr.	M. N. Waterman
W. C. Brown	R. R. Wylie
W. V. C. Foulks	R. M. Zabel

TESTING PROCEDURES FOR ILLUMINATION CHARACTERISTICS — To prepare standard test procedures for illumination characteristics of light sources, lighting equipment and illumination materials, and to report thereon.

Ray P. Teele, Chairman, 3713 Jenifer Street, N. W., Washington 15, D. C.

A. C. Barr	Rudolph Hultgren
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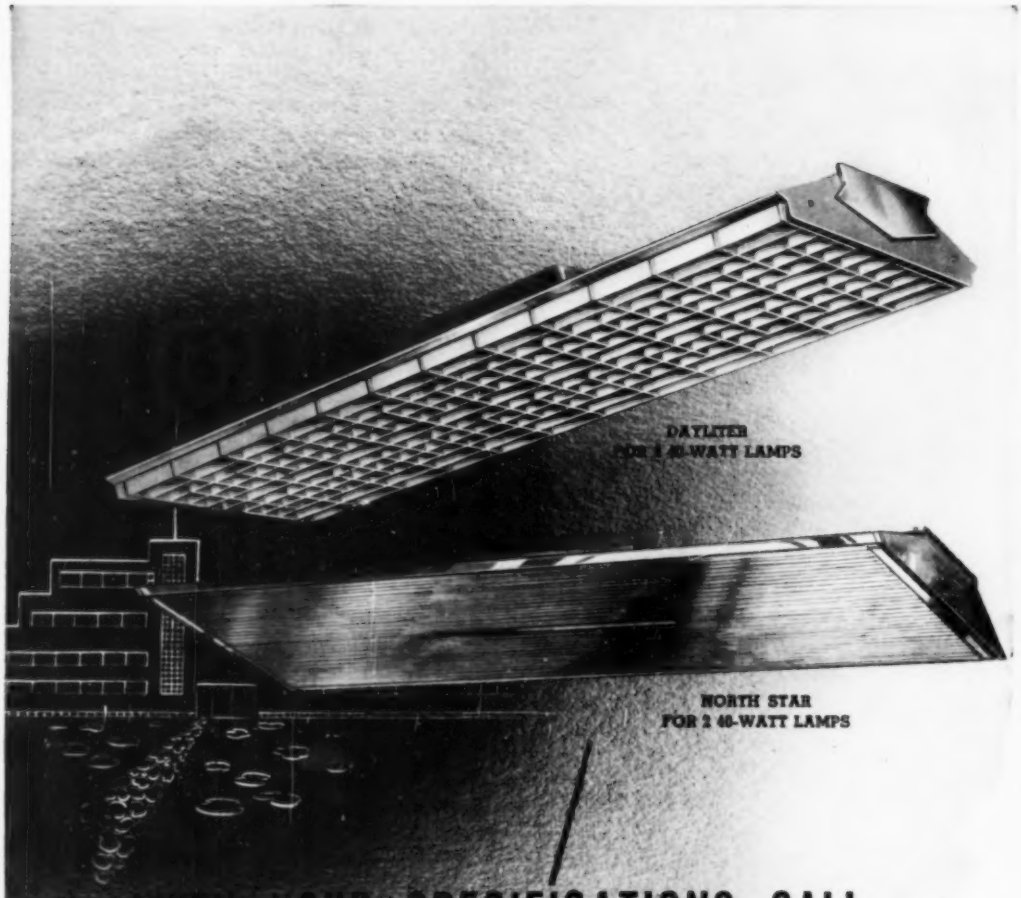

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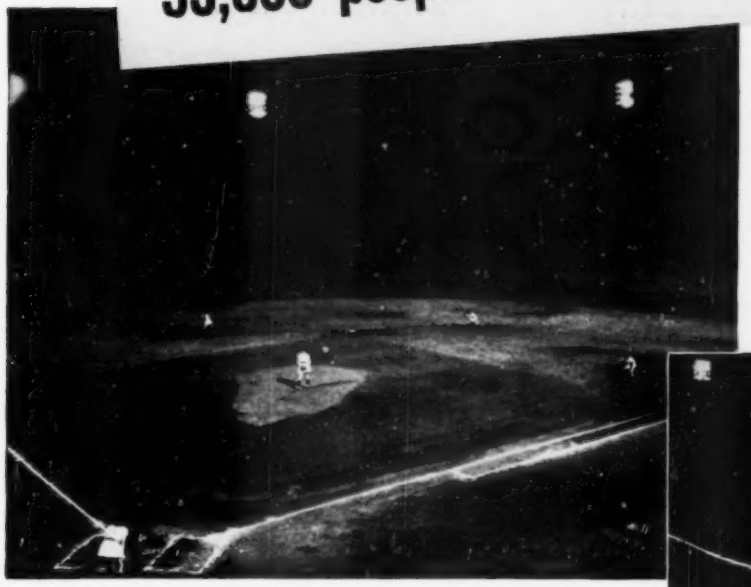

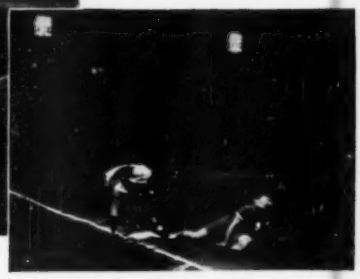

To give an idea of the lighting at Simmons Field, this photograph was taken at F5.6, 1/5th second, on Super XX film.

This is Simmons Field in Kenosha—one of Wisconsin's stand-out ball parks and one of *five* lighted recreational areas in this city of 55,000 population. Together these lighted parks have drawn as many as 20,000 people in one evening—have been instrumental in cutting juvenile delinquency and have greatly reduced vandalism in the city parks.

Simmons Field itself—named after Simmons Company who donated the land—seats 2600 and has averaged 1500 admissions per night. Our part of course was the lighting. Simmons Field uses a standard G-E "160" lighting system—planned, ordered, and installed according to "the book."

YOURS FOR THE ASKING—This is "the book" that contains 38 complete floodlighting plans for sports and recreation. One is the "160" lighting system used at Simmons Field—160 G-E floodlights on 10 80-foot steel poles—complete with a list of all material required down to concrete and paint. Among other plans are tennis courts, volley ball and 12- to 48-lamp softball fields. *Address Apparatus Dept., General Electric Co., Schenectady 5, N. Y. and ask for GET-1284.*

THE SPORTS LIGHT—This is the floodlight used at Simmons Field, the G.E. L-69. It gives more light per unit, more light per watt, is easier to install and cheaper to maintain than any other comparable unit. It's so good that four major-league parks use it, so economical that it's the favorite for sand-lot softball. Bulletin GEA-4835 gives complete description and prices.

GENERAL ELECTRIC

NEW! FLUORESCENT Sun Lamps

Westinghouse Lamp Data

This fluorescent sun lamp, the most powerful ever produced, provides a means of bathing wide areas with beneficial ultraviolet light.

In appearance the lamp looks like a regular fluorescent lamp. Its rays are soft and diffuse so that it can be mounted overhead for uniform and economical room irradiation. A newly developed phosphor powder, which generates the healthful energy, is used to coat the inside surface of the ultraviolet transmitting glass.

Wide Variety of Applications

The new lamp's efficiency is five times that of the screw-in bulb-type sun lamp. Thus it is ideal for use in schools, factories, offices, mines, and underground industries. In such places, it provides beneficial ultraviolet, similar to that in natural sunshine.

It is also usable for suntanning. An exposure of approximately five minutes to a 40-watt sun lamp, mounted in a suitable reflector two feet away, is sufficient for a tan. This feature will appeal to operators of gymnasiums, hospitals, solaria, barber and beauty shops.

Uses Standard Accessories

The lamp is available in 20- and 40-watt sizes. The dimensions and electrical characteristics are the same as those for the present Westinghouse fluorescent lamps of the same ratings. Consequently the new sun lamps can be operated in standard fluorescent fixtures.

For more information about the new Westinghouse sun lamp, write Lamp Division, Westinghouse Electric Corp., Bloomfield, N. J.

TECHNICAL DATA

	20-WATT LAMP	40-WATT LAMP
Bulb diameter	1½"	1½"
Lamp Length	24"	48"
Operating Amperes	0.36	0.415
Operating Volts	60	106
Base	Medium Bipin	Medium Bipin
Rated Avg. Life	2500 at 3 hours start 4000 at 6 hours start	2500 at 3 hours start 4000 at 6 hours start

YOU CAN BE SURE...IF IT'S Westinghouse

USE MONA-LITE*

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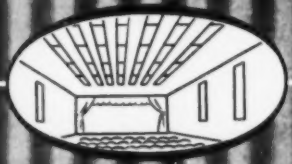
Waiting Rooms

Auditoriums



When you plan the lighting of conference rooms, waiting rooms, auditoriums, etc., where fixtures may be in the field of vision for extended periods, lighting panels should be low in brightness to prevent eye fatigue.

MONALITE,* Corning's newest opal, with the special quality of low transmission, meets this requirement. When suspended open top fixtures equipped with MONA-LITE provide adequate ceiling illumination due to the high reflection factor of the glass. Box type fixtures with MONA-LITE panels have achieved brightness levels as low as .5 candles per square inch!

Providing color tones approximating those of incandescent, MONA-LITE actually imparts a soft, warm tone to fluorescent light. It is also recommended for installations which combine fluorescent and incandescent light sources. For complete data on MONA-LITE, ALBA-LITE, and other Corning Lightingware, **send for bulletin LS-17.**

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Please send me your Data Book LS-17, "Corning Engineered Lightingware," describing MONA-LITE, ALBA-LITE and other Corning products.

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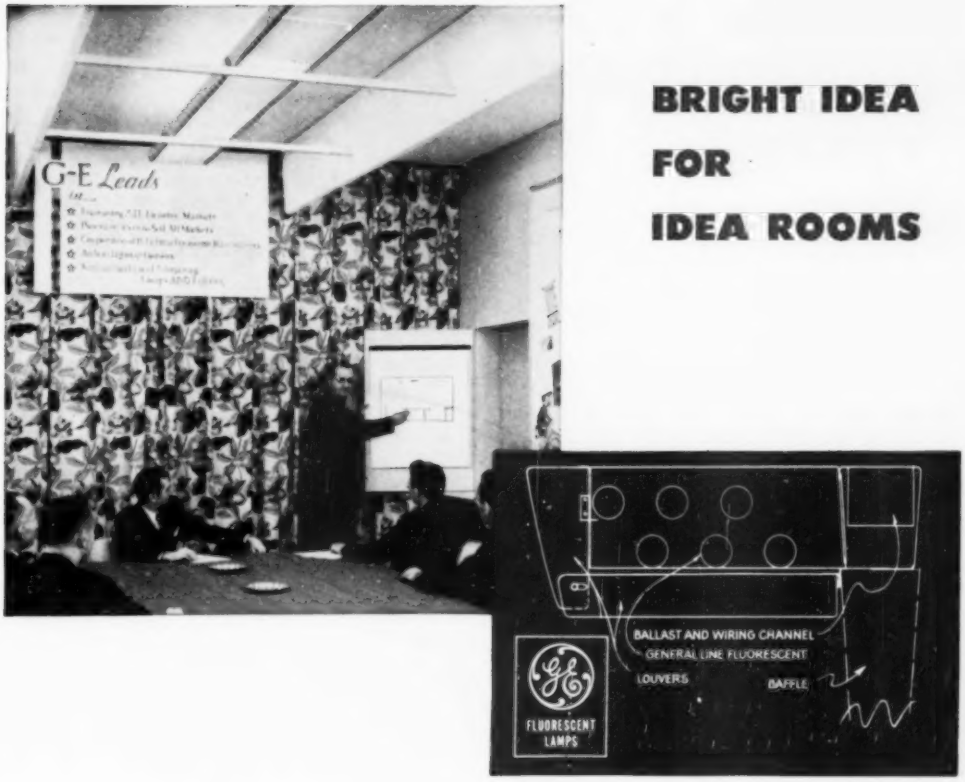

BRIGHT IDEA FOR IDEA ROOMS

IDEAS come easier in a comfortable, well-lighted conference room like the one above. The General Electric 40-watt, instant-start fluorescent lamps in ceiling fixtures provide 60 footcandles of soft, comfortable light on the table, yet are shielded from direct view. Charts and displays on the tackboards are highlighted by the same ceiling lamps.

The two rows of G-E Lumiline lamps in the center of the ceiling provide a "bridge" between blackout (for film projection) and full lighting. They are controlled by a dimmer rheostat at the end of the table.

Whether you're designing a conference room, a home, or a department store, be sure to specify General Electric lamps. Their quality is assured by over 480 tests and inspections. And the more than 10,000 types and sizes of G-E lamps are being constantly improved by research to *Stay Brighter Longer*.

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FLUORESCENT
Many new types, sizes, colors now available.

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spot or flood. Moulded glass for ruggedness.

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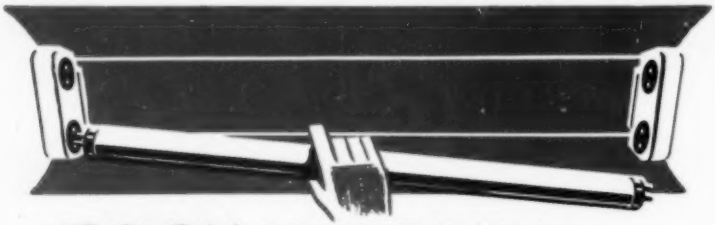

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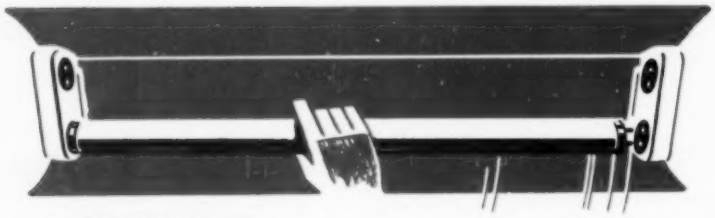
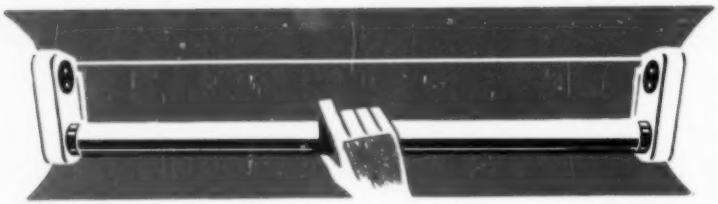
(A SLIGHT TWIST SEATS LAMP PINS)



SWING FREE END OF LAMP UP



POP! IT'S FIRMLY IN

Re-lamping G-E Turret* fluorescent lampholders is as easy as that. No need to fit the lamp accurately in place. No gadgets to hold the lamp firm. Turret lampholders actually make re-lamping a one-hand job.

This easy-maintenance story can be a real sales help to you. Manufacturers now using G-E Turret lampholders have found them effective in making sales—many more are turning to Turrets as the ideal fluorescent lampholder.

In addition to their sales appeal, you'll find Turrets are built to speed fixture assembly. They mount easily on any flat surface—terminal holes are marked for positive identification—and starter sockets are built in. (Turrets are made for two- or three-lamp fixtures.) For more information, contact the G-E accessory equipment representative in your area, or write to Section Q35-287, Construction Materials Department, General Electric Company, Bridgeport 2, Connecticut.

*Trade-mark Reg. U. S. Pat. Off.

YOUR FIXTURES will keep customers happy long after installation, if you equip them with General Electric Watch Dog* starters. Watch Dogs are the starters that stop lamps cold when they begin to blink. They cut out the annoyance of flickering lamps—prolong starter and ballast life. Watch Dogs can be reset easily by merely pushing a button.

SWITCHES—Turn-type manual starting fluorescent switches are part of the complete General Electric line. They are available with coded leads attached, for easy wiring and assembly. Switches are another point in your sales story of "General Electric all the way through, from power cord to lampholder."

CIRCLINE LAMPHOLDERS—To give you complete design flexibility on Circline fixtures, General Electric offers you two types of lampholders. The channel type includes two-point mounting complete with starter switch and leads. These units are furnished with threaded bushings for easy assembly. The individual-type lampholders offer three-point mounting—one with leads for electrical connections, and two for tension supports. These are supplied to provide more flexibility in design.

GENERAL ELECTRIC SERVICE may be able to help you over rough spots in supply and manufacture. If you would like information on our wiring assembly service—if you would like to know about our merchandising aids—if you would like to know more about General Electric components—contact the G-E accessory equipment representative in your area, or write to Section Q35-287, Construction Materials Department, General Electric Company, Bridgeport 2, Connecticut.

GENERAL ELECTRIC

Turret Lampholders

CURRENT ARTICLES ON LIGHTING

(Continued from page 127)

ing, *Signs of the Times*, December 1948, p. 67.

Cold Cathode in Miami Ticket Office, *Signs of the Times*, December 1948, p. 68.

Shoe Store Makes Good Use of Cold Cathode in Interior Lighting and Sign, *Signs of the Times*, December 1948, p. 70.

Two-Level Installation Provides Uniform Light, *Signs of the Times*, December 1948, p. 72.

Windows Lighted Right for Day or Night, *Lighting for Business*, January 1949, p. 2.

Women's Wear, *Lighting for Business*, January 1949, p. 6.

Lighting a Men's Wear Department, by Larry Clementson, *Display World*, December 1948, p. 28.

Macy's Modernizes, *Display World*, December 1948, p. 110.

Wax Coating Protects Street Lighting Reflectors, by Walter Skove and Anthony Nichols, *Electrical Light and Power*, December 1948, p. 98.

Pin Point Lighting for High Style Fashions, *Lighting and Lamps*, December 1948, p. 34.

Manual of Lighting Fixture Design, Edwin D. Tillson, *Lighting and Lamps*, December 1948, p. 36.

Fluorescent Is Innovation in Largest Postwar Liner, *Lighting and Lamps*, December 1948, p. 41.

Lighting the Inn-Type Hotel, *Lighting and Lamps*, December 1948, p. 42.

Versatility of Planned Lighting, *Lighting and Lamps*, December 1948, p. 45.

Exhibition Lighting, by L. E. W. Stokes-Roberts, *Light and Lighting*, November 1948, p. 232.

Help on Fluorescent Lamp Maintenance, by Thomas Trail, *Industry and Power*, January 1949, p. 78.

Symbols Developed for Distribution Maps, III—Street Lighting Circuits, *Electrical World*, January 1, 1949, p. 66.

Influence of Lighting Equipment on Design, *Progressive Architecture*, January 1949, p. 68.

Six Recommended Lighting Systems for Industry, by J. C. Forbes and E. A. Linsday, *The Magazine of Light*, Volume 17, No. 4, p. 10.

Cincinnati's Newest Hotel, *The Magazine of Light*, Volume 17, No. 4, p. 22.

Cincinnati's New J. C. Penney Store in the Terrace Plaza Building, *The Magazine of Light*, Volume 17, No. 4, p. 28.

The Rate of Blinking during Prolonged Visual Search, by A. Carpenter, *Journal of Experimental Psychology*, 38, 1948, p. 587.

(Continued on page 16A)

There's No Better Way To Hang

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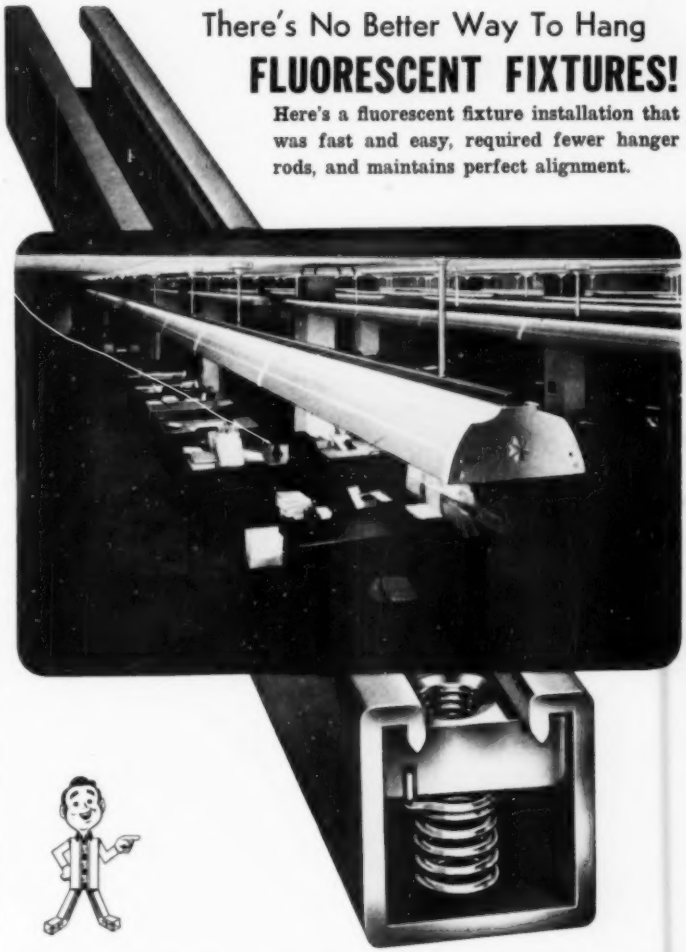
Here's a fluorescent fixture installation that was fast and easy, required fewer hanger rods, and maintains perfect alignment.



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You also can quickly, easily and economically build all types of shelving, framing, supports, mounts, racks, tables and benches—pipe and cable hangers, and fluorescent supports—and many other structures with only a hacksaw and wrench.

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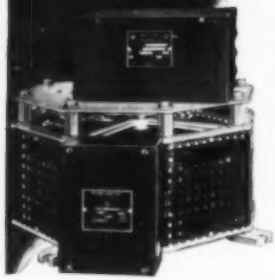

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LIGHT DIMMING EQUIPMENT

Judicious use of church lighting can intensify the atmosphere of dignity and reverence. The mere push of a button and the POWERSTAT motor-driven unit silently brightens or dims lights to set the mood for sermon, prayer or choir rendition. POWERSTAT light dimming equipment helps you achieve the proper lighting treatment; should be included in your plans for new building or for renovation.

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(*Continued from page 15A*)

The Ophthalmic Aspects of Illumination, Brightness and Color, by Faber Birren, *Transactions of the American Academy of Ophthalmology and Otolaryngology*, May-June 1948.

ARTICLES ON HOME LIGHTING

Christmas Tree Lighting Gets Better Every Year, *House Beautiful*, December 1948, p. 218.

Go All Outdoors with Christmas, *House Beautiful*, December 1948, p. 140.

Lighting for Reading in Bed, by Myrtle Fahsbender and Priscilla Presbrey, *Better Light, Better Sight News*, Vol. 16, No. 7, 1948, p. 2.

We Live with Fluorescent Light and Love It, by Carolyn Ohart, *Better Light, Better Sight News*, Vol. 16, No. 7, p. 4.

What to Do About Stepchild Mirrors, by Mary Webber, *Better Light, Better Sight News*, Vol. 16, No. 7, p. 10.

Easy on the Eyes, excerpts from book of this title by Winifred Hathaway, *Better Light, Better Sight News*, Vol. 16, No. 6, p. 8, also Vol. 16, No. 7, p. 12.

Good Light and Good Looks, *House and Garden*, November 1948, p. 208.

GE's Mary Webber Urges Better Study Lamps, *Lamp Journal*, November 1948, p. 26.

Sylvania Opens New Lighting Center, *Lighting and Lamps*, November 1948, p. 52.

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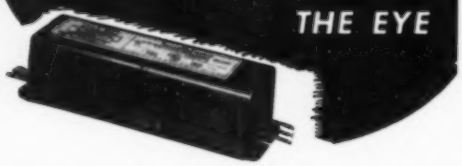

It's possible to pick out Acme Electric fluorescent ballast equipped fixtures in service by noticing these important performance features. First—all lamps of multiple lamp fixtures light up at the same instant as a result of full rated watt output. Second—no flicker in operation because secondary voltage exactly complies to lamp operating voltage. Third—noise-free because cores have no loose laminations, are thoroughly impregnated and sealed in compound. These are a few of the important features of Acme Electric ballasts that assure better performance, and longer service to fluorescent lamps.

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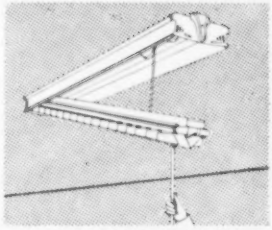
With a twist of the maintenance rod all working parts swing down for **ladderless** servicing right from the floor!



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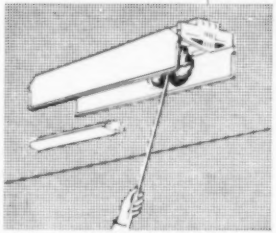

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makes the dusting ladder obsolete. Diffusing glass panels are easily swung open and dusted right from the floor!

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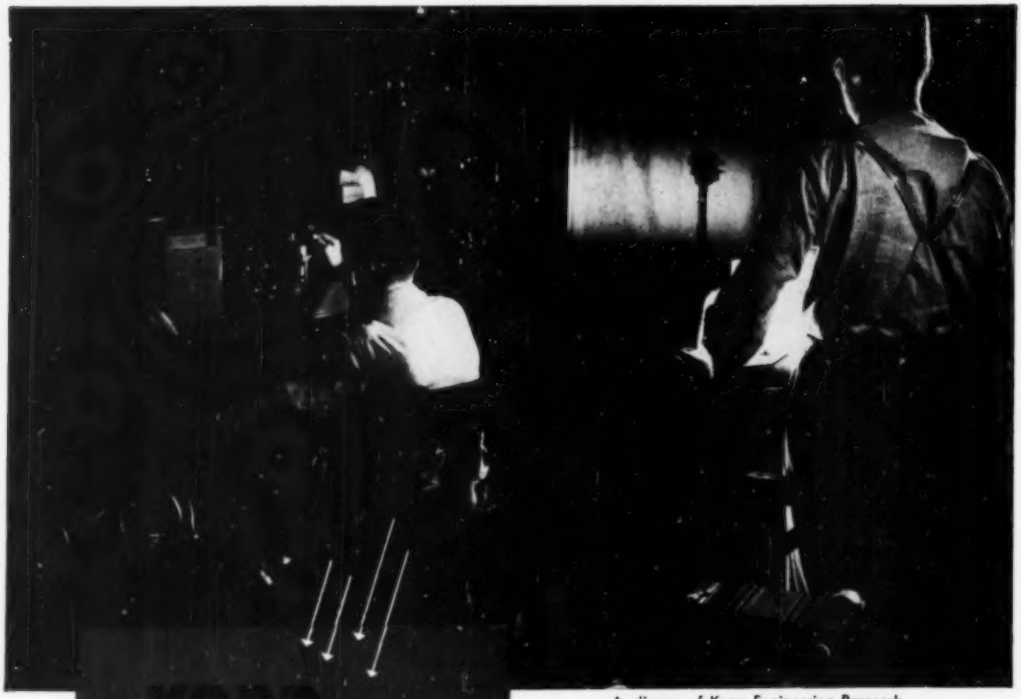

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Precision grinding of Kopp Glass parts

Representative Kopp Indicator Glasses

KOPP GLASS parts fit snugly, transmit colors clearly, control distribution of light accurately, resist abrasion, shock or thermal shock—and otherwise fulfill your requirements—because Kopp *takes pains* in the design, manufacture and inspecting of all products.

If you want highest quality glass parts for indicator lights, beam control, sight glasses, mechanism cases, or other service—specify KOPP!

KOPP GLASS

KOPP GLASS · INC.
SWISSVALE, PA.

NAME OF MANUFACTURER

COMPLIANCE WITH
SPECIFICATIONS AND
APPROVED INSTALLATION
OF [illegible] RLM
STANDARDS ENTITLES
ELECTRICAL TESTING
LABORATORIES, INC.

this LABEL MEANS...

PORCELAIN ENAMEL REFLECTORS ARE ESSENTIAL TO A GOOD LIGHTING PLAN!

1. For fluorescent lighting, as well as incandescent lighting, units bearing the RLM LABEL give assurance of important benefits. For example, this label warrantees that the reflectors are Porcelain Enameled on Steel. That means the reflectors excel in *sustained lighting efficiency, durability, ease of cleaning* and *low-cost maintenance.*

Unlike baked, synthetic or paint enamel finishes, which are chiefly organic, *real Porcelain Enamel* is Vitreous Enamel, *entirely inorganic.* It is a mineral substance, fused to steel at 1550°F. Flint hard and non-porous, it cannot wear, scratch or become dull. It is immune to deterioration, corrosion and weathering. It is the only time-proven, commercially-used light reflecting surface whose original efficiency can be sustained year after year by simply washing with soap and water.

Further, Porcelain Enamel is unsurpassed as a reflecting surface. It ideally combines a high reflection factor with a high diffusion factor. This balance insures a *quality* of light which promotes seeing comfort, high light output with a minimum of glare, and more light for the vertical surfaces as well as the horizontal planes.

2. The label assures you, too, that the Porcelain Enamel meets important *quality* specifications established by the RLM STANDARDS INSTITUTE. Conformance to these specifications is assured through periodic inspections by the Electrical Testing Laboratories. Thus specification of the RLM LABEL warrantees not only that the reflectors will be of *high quality* Porcelain Enamel, but that this *high quality* will prevail *uniformly* from fixture to fixture.

NEW LIGHT ON PLANNED LIGHTING
THIRD INTERNATIONAL LIGHTING EXPOSITION and CONFERENCE
CHICAGO
MAR. 29 to APR. 4
Photo-micrograph shows how Porcelain Enamel is fused right to the reflector steel.
Fluorescent RLM Specification:
"Reflector steel thickness: not less than .032 inches."
ASSURES RIGIDITY
Fluorescent RLM Specification:
"Porcelain enamel no thicker than .025 inches."
ASSURES CHIP-RESISTANCE
Fluorescent RLM Specification:
"Mean reflection factor: 79%."
ASSURES EFFICIENCY
Fluorescent RLM Specification:
"Surface must be free from tears, star marks, crazing, blisters, black specks, hair lines, chipping, pin holes and other irregularities."
ASSURES DURABILITY

RLM STANDARDS INSTITUTE
INCORPORATED

The letters RLM stand for Reflector and Lighting Equipment Manufacturers

Porcelain Enamel is just one of the important specifications which lighting units must meet in order to carry the RLM LABEL. *It is one more intelligent reason why you should buy, specify and install fluorescent fixtures bearing the* RLM LABEL . . . *your Warranty for Uniform Quality. For details concerning standard specifications established for 14 different fluorescent and incandescent lighting units, as well as a list of manufacturers making them, write to the* RLM STANDARDS INSTITUTE. *Suite 823, 919 West Madison Street, Chicago 6, Illinois.*

Outstanding

"SYLVANIA FIRSTS OF 1948"

NUMBERED among the many Sylvania advances in the lighting field are these outstanding developments, products of the research and manufacturing skills that have made possible equally outstanding "Sylvania Firsts" in the fields of Radio, Television, FM, and Electronics.

WARMTONE

The first fluorescent lamp simulating the color tone of incandescent illumination. Hailed in thousands of stores, homes, offices.

75 WATT T12

This fastest-starting, 8-foot, 1½ diameter hot-cathode lamp produces considerably more light than any other fluorescent lamp — has many applications in general and showcase lighting.

PAR 38

New street lamp, with built-in reflector. Made to give more light on street side where needed than on house side. Resists breakage!

INCREASED LIFE MORE LIGHT

New Sylvania Fluorescent Lamps last far longer and give far more light than ever before.

FLUORESCENT FIXTURE GUARANTEE

Sylvania now guarantees for one year its entire line of fluorescent fixtures equipped with Sylvania Lamps in orders of 25 or more units for one installation.

500 FIFTH AVE., NEW YORK 18, N. Y.

SYLVANIA ELECTRIC

FLUORESCENT LAMPS · FIXTURES · WIRING DEVICES · ELECTRIC LIGHT BULBS · PHOTOLAMPS · RADIO TUBES · CATHODE RAY TUBES · ELECTRONIC DEVICES